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SOBOTTA-PIERSOL
HUMAN HISTOLOGY

TEXTBOOK AND ATLAS OF
HUMAN HISTOLOGY
AND MICROSCOPIC ANATOMY

BY DR. JOHANNES SOBOTTA
PROFESSOR OF ANATOMY AND DIRECTOR OF THE ANATOMICAL INSTITUTE IN BONN

TRANSLATED BY
WILLIAM HUNTER PIERSOL
PROFESSOR OF HISTOLOGY AND EMBRYOLOGY IN THE UNIVERSITY OF TORONTO

VOLUME I: TEXTBOOK
WITH 42 DIAGRAMMATIC ILLUSTRATIONS

VOLUME II: ATLAS
WITH 535 ILLUSTRATIONS ON 68 COLORED AND 24 UNCOLORED PLATES

1930

G. E. STECHERT & CO., NEW YORK

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AND MICROSCOPIC ANATOMY

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FROM THE FOURTH GERMAN EDITION, GREATLY ENLARGED AND ENTIRELY REWRITTEN

WITH 535 ILLUSTRATIONS ON 68 COLORED AND 24 UNCOLORED PLATES
FROM ORIGINAL DRAWINGS BY W. FREYTAG

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[1] In addition to Plates 1—18 numerous separate representations of tissues are also contained in the Plates which follow, particularly Plates 19, 20, 21, 27, 28, 30, 34, 35, 39, 44, 49, 53, 59, 60, 80, 92.

Plate 1. **Cell and Cell Division.**[1]

Fig. 1. A Typical **Human Cell** with its Three Principal Parts: **Protoplasm** (Cytosome) **Nucleus and Centrosome.** Interstitial cell from the testis of a man aged 22 years who had been executed. × **1500.**

No special structures are visible in the protoplasm except a condensation near the nucleus, the so-called archoplasm, containing a clear area within which is the centrosome in the form of a diplosome. The nucleus is not in the center, is irregular in form and shows nuclear network and nucleoli.

Technique: Zenker's fluid. Paraffine, Bordeaux red-iron haematoxylin.

Fig. 2. **Nucleus** of a Human **Connective-tissue Cell** (Reticulum Cell) from a Lymph Gland. × **1500.**

The nucleus is somewhat irregularly rounded, shows a network of finely divided chromatin and three large acidophile nucleoli.

Technique: Sublimate—salt solution; otherwise as for *Fig. 1.*

Figs. 3—5. **Indirect (Mitotic) Nuclear and Cell Division** from the Germ Center of a Human Lymph Gland. × **1500.**

Fig. 3 represents a monaster viewed from a pole, *Fig. 4* the same in profile. *Fig. 5* shows a distinct dyaster stage. Note the comparatively small number of chromosomes in *Figs. 4 and 5.* In man counts of chromosomes vary from 24 to 52, the correct number is probably 48; although here it is less.

Technique as for *Fig. 2.*

Figs. 6—15. Ten Successive Stages of **Indirect** or **Mitotic Nuclear** and **Cell Division.** Epithelium from the Floor of the Mouth of a Larva of Salamandra maculata. × **1500.**

Fig. 6. Cell with resting nucleus shortly before the beginning of the process of division. Nucleoli already dissolved, centrosome not visible. *Fig. 7.* Beginning of mitosis proper; stage of the close spireme; nuclear membrane still retained; chromosomes clearly formed but as yet interlaced irregularly and occupying the entire space within the spherical nucleus. *Fig. 8.* Stage of the open spireme; the nuclear membrane has dissolved; the group of chromosomes lies bare in the protoplasm; the chromatic loops begin to take positions with the curves turned toward one pole and the free ends toward the opposite pole, the antipole; *i. e.* away from the centrosome (not visible). *Fig. 9.* Monaster stage viewed in profile; the achromatic spindle is fully formed (cf. *Fig.* 3 Pl. 2) and the chromosomes form a ring at the equator of the spindle; in the upper part of the achromatic figure are two aberrant chromosomes. *Fig. 10.* Polar view of monaster. *Fig. 11.* Profile view of stage of the monaster; the chromosomes form a complete ring at the equator of the spindle. *Fig. 12.* Beginning of metakinesis; the daughter asters formed after the longitudinal division of the chromosomes begin to separate and move toward the poles of the spindle. *Fig. 13.* Stage of the fully developed diaster; the daughter asters are further removed from one another; the constriction of the cytosome has begun. *Fig. 14.* Stage of the daughter spiremes (dispireme); the division of the cytosome is completed; each daughter cell contains a group of chromosomes in the process of transformation from an aster into a spireme. *Fig. 15.* Division of nucleus and cell is complete; each of the daughter cells contains a resting daughter nucleus in the telophase. Notice that *Figs. 6—15* reproduce entire cells, not sections of cells.

Technique: Well fed larvae fixed in 2% chromic acid solution; otherwise as for *Fig. 1.*

Figs. 16—20. Five Stages of **Mitotic Division** in the **Fertilized Egg** of **Ascaris megalocephala.** × **1000.**

Fig. 16. First segmentation spindle of the fertilized egg; profile view of the monaster; the centrosomes are sharply stained and stand out clearly lying in an area of granular protoplasm (archoplasm); four thread like chromosomes form an equatorial plate; in the protoplasm are vacuoles. *Fig. 17.* Diaster; after longitudinal division of the chromosomes one daughter aster, consisting of four elements, moves toward each pole; the cell, previously spherical, has become slightly elliptical. *Fig. 18.* Increased separation of the daughter asters, beginning of the ringlike constriction of the cytosome which leads to cell division; the centrosomes, previously spherical, have become flattened discs. *Fig. 19.* Division of the cytosome is complete, reconstruction of the daughter nuclei from the daughter spiremes has begun, in the smaller cell to the left a nuclear membrane has already formed; each daughter cell contains about half of the protoplasm, half of each chromosome of the mother nucleus and one centrosome. *Fig. 20.* The division of nucleus and cell is finished; the resting stage of the daughter nuclei is fully developed; no centrosome is visible.

Technique: Glacial acetic—sublimate. Paraffin; otherwise as for *Fig. 1.*

ar = archoplasm
c = centrosome
ch = chromosomes
k = nucleus
kg = nuclear network
km = nuclear membrane
n = nucleolus
po = polar field
pr = protoplasm
tk = daughter nuclei
tkn = daughter spireme
tst = daughter aster
tz = daughter cells
vf = connecting fibers
* = isolated chromosomes
+ = constriction of cytosome

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[1] Cf. also Plate 2.

Tab. 1

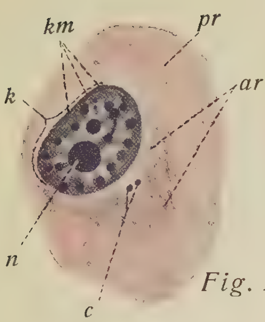
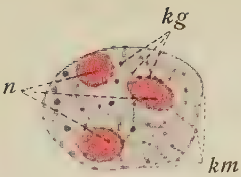


Fig. 1



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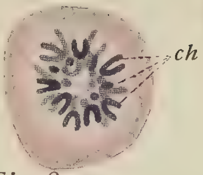

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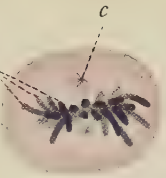

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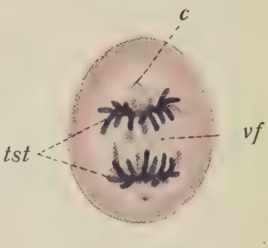

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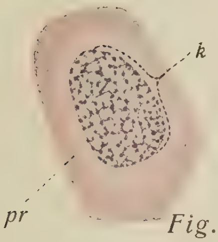

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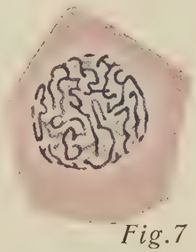

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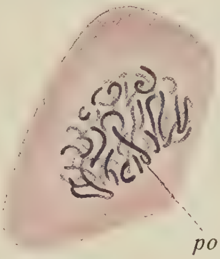

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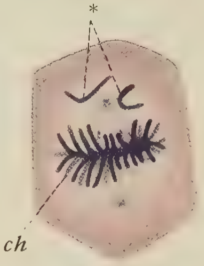

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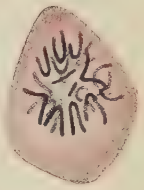

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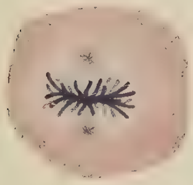

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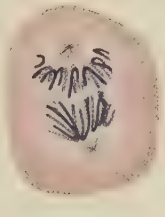

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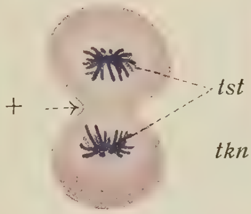

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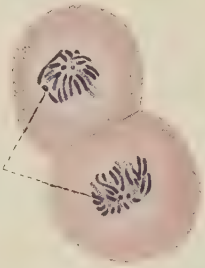

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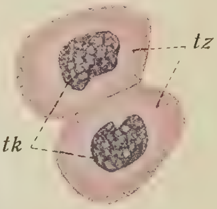

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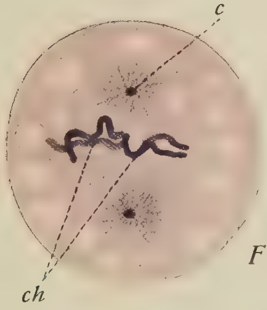

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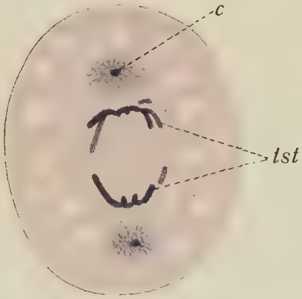

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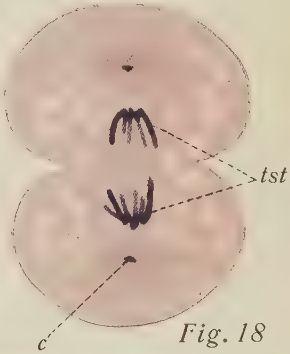

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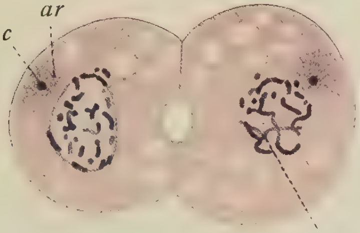

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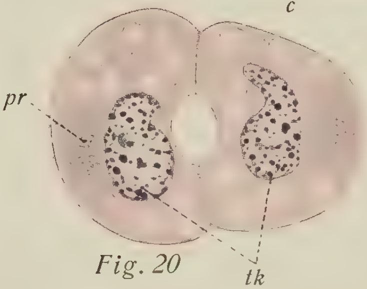
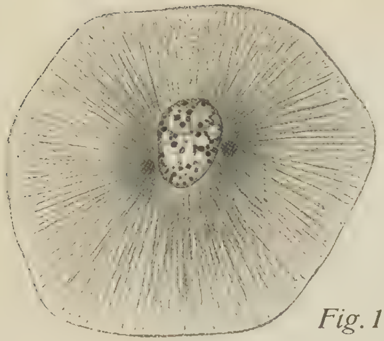


Fig. 20

Tab. 2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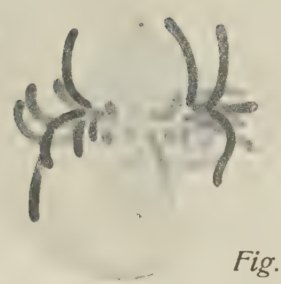
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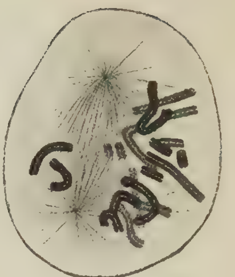
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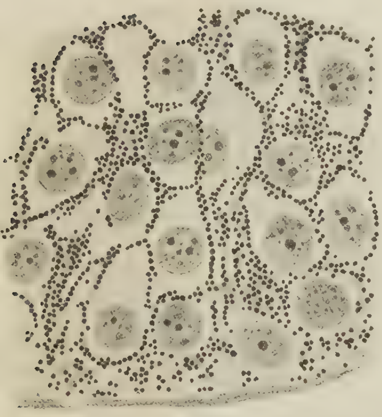
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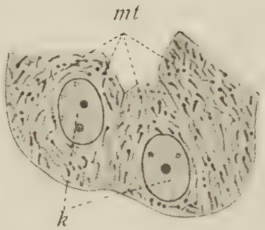

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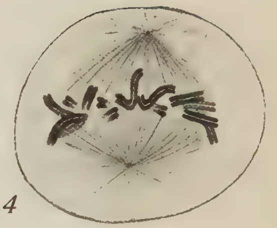
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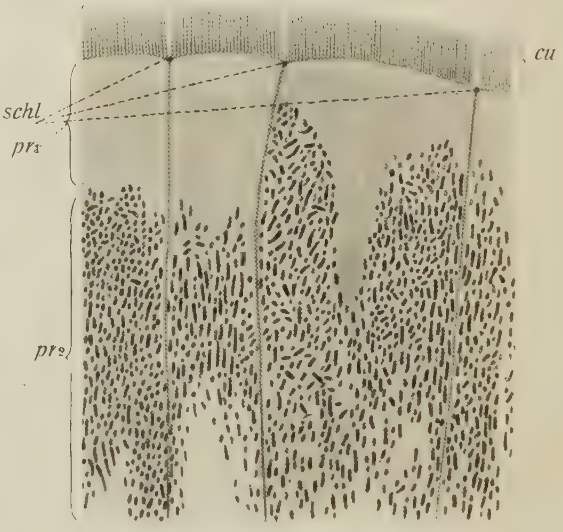
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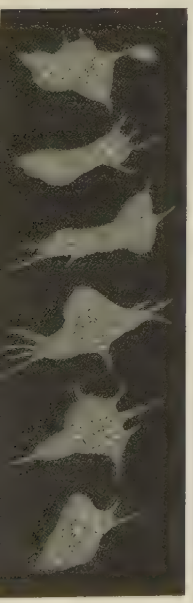
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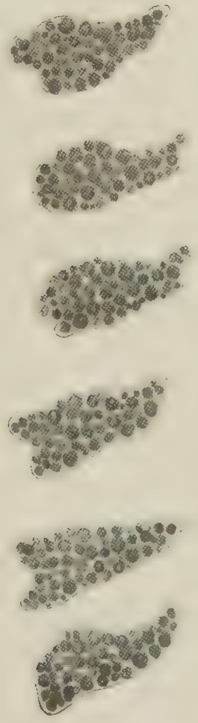
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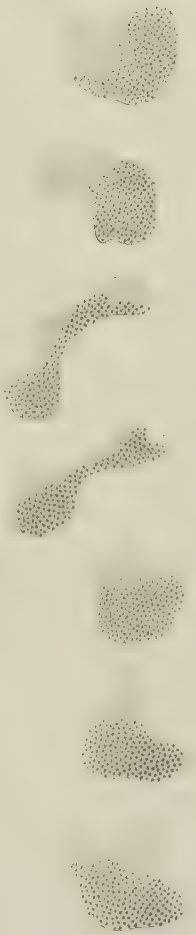
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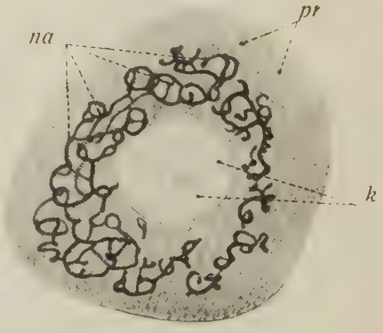

Fig. 8

Plate 2. Cell, Cell Division, Cell Structure.

Fig. 1. **Blastomere of a Teleost** (Belone acus). × **1000**. An example of an approximately spherical cell with resting nucleus at its center, distinctly fibrillar structure of the cytoplasm, two centrosomes beside the nucleus.

The nucleus shows moderately well the nuclear network; the whole cytosome is traversed by radiating fibrils of protoplasm which proceed from the region of the nucleus and may be followed to the surface of the cell. Other fibrils are clearly seen which are cut across and appear as points. The centrosomes merely lie among these fibrillar—structures and do not represent centers of astropheres.

Technique: Chromacetic acid—picrosublimate, Paraffine. Haematoxylin.

Fig. 2. Cell in the **Monaster Stage** of **Indirect Nuclear Division.** × **1500.** Cell from the testis of Salamandra maculata.

The bulging figure of the achromatic spindle shows distinctly with the centrosomes at the poles and the polar radiations proceeding from them. At the equator of the figure is a ring of especially long chromosomes whose free ends are strongly bent toward the poles.

Technique: Platinum chloride—osmo-acetic acid. Paraffine, Iron haematoxylin.

Fig. 3. **Indirect Cell Division; Transition from Spireme to Monaster.** Epithelial Cell from the floor of the mouth of a larva of Salamandra maculata. × **1500.**

The achromatic spindle has almost reached its full length; the chromosomes do not yet lie on the equator of the spindle but nearly all are close together and lie at the right of the spindle almost in the places they held in the spireme. So far only two have moved into the equatorial plane; the longitudinal cleft shows clearly in all. **Technique** as for Pl. 1, *Figs. 6—15.*

Fig. 4. **Monaster Stage of Indirect Cell Division.** × **1000.**

A clear and typical view of the stage seen in profile. Chromosomes drawn close together at the equator; longitudinal cleft in each already very distinct. **Object and technique** as in *Fig. 3.*

Fig. 5. **Mitochondria (Plastosomes)** in Cells from the Tubuli Contorti of the Testis (Mouse). × **800.**

The nuclei of the cells are inconspicuous, and in general cell boundaries are not visible; the uniformly granular mitochondria or plastosomes are clearly seen.

Technique: Chrom-osmo-acetic acid. Paraffine. Benda's crystal violet staining.

Fig. 6. **Mitochondria (Plastosomes)** in Cells of the Thyreoid Gland (Mouse). × **1000.**

Mitochondria in the form of rods are clearly seen within the cytoplasm.

Technique: The osmo-haematoxylin method of O. Schultze.

Fig. 7. **Mitochondria (Plastosomes)** in the Intestinal Epithelium of Ascaris megalocephala. × **1000.**

An example both of membrane formation (cuticula) on the surface of the cell, and of the union of cells by cement and terminal bars. There are seen the parts adjacent to the free ends of a few long columnar cells which lie side by side; the nuclei of the cells are in their lower parts and are not shown. On the surface is a very distinctly striated cuticular border; between the cells a thin layer of cement which is thickened above to form terminal-bars. No plastosomes are to be recognized in the superficial zone of the cytoplasm, in the deeper parts they appear very clearly as short rod-like structures. **Technique** as for *Fig. 6.*

Fig. 8. **Reticular Apparatus** of a Nerve Cell. × **1000.**

The round nucleus of the cell appears quite pale. In the surrounding cytoplasm are seen in black the threads of the reticular apparatus like a shell enclosing the spherical nucleus.

Technique: Formol—uranium nitrate-alcohol. Silver nitrate reduced by hydrochinone. Paraffine.

Fig. 9. **Colorless Blood Cell in Amoeboid Movement (Frog).** × **800.**

The changes in the shape of a leucocyte are pictured during three minutes of amoeboid movement. Distinct granulations in the cytoplasm; nucleus not visible.

Fig. 10. **Colorless Blood Cell with Phagocytosed Foreign Matter** (Particles of Carbon), and in Amoeboid Movement **(Frog).** × **1100.**

Thirty-six hours before death so-called soluble chinese ink had been injected into the subcutaneous lymph sac.

Fig. 11. **Colorless Blood Cells in Amoeboid Movement (Frog). Dark field illumination.** × **700.**

The fine protoplasmic processes or pseudopodia stand out with special distinctness against the dark background.

cu = cuticular border
k = nucleus or nuclei
mt = mitochondria or plastosomes
na = reticular apparatus

pr = protoplasm
pr_1 = protoplasm without plastosomes
pr_2 = protoplasm with plastosome inclusions
schl = terminal bars

Plate 3. **Epithelial Tissue I.**

Fig. 1. **Stratified Squamous Epithelium** from the Human Mouth. × **280.** The preparation shows the typical arrangement of the cell layers in this type of epithelium — columnar below, then rounded-polyhedral, becoming flat above; indentations in the epithelium are caused by the papillae of the tunica propria (not shown). **Technique:** Müller's fluid. Haematoxylin-eosin.

Fig. 2. **Simple Columnar Epithelium** from the Intestine (Human, aet. 22. Execution). × **420.** To the left are three, to the right a greater number of firmly united cells of cylindrical or conical form with distinctly striated cuticular border on the free surface. Wandering cells in the epithelium. **Technique:** Potassium bichromate—formol. Haematoxylin-eosin.

Fig. 3. **Simple Columnar Ciliated Epithelium** from the Ampulla of the Human Oviduct. × **1000.** The basal corpuscles and cilia show very distinctly. **Technique:** Zenker's fluid. Paraffine, very thin section. Haematoxylin-eosin.

Fig. 4. **Epithelium** from the **Ductus Epididymidis.** (Human, aet. 21. Execution.) × **1000.** A very high epithelium of several rows of cells. Border of stereocilia. A basal layer of flat cubical cells can be recognized and a superficial layer of high columnar cells with elliptical nuclei in two rows. Terminal bars are to be seen but no basal corpuscles. **Technique** as for *Fig. 3.*

Fig. 5. **Transitional Epithelium** from the Human Ureter. × **520.** An upper layer of dark-staining cells is to be seen with a superficial condensation like a crusta; beneath it are 1—2 layers of clear cubical-columnar cells with rounded tops indenting the lower surfaces of the superficial cells. The cells of the basal layer are cubical. In the epithelium are two leucocytes (wandering cells). **Technique:** Sublimate. Paraffine. Haematoxylin-eosin.

Fig. 6. **Simple Squamous Epithelium** from the Great Omentum (Rabbit). × **280.** **Technique:** A thin area of the omentum was treated with solution of silver nitrate which has blackened the cell boundaries of both upper and lower layers of the peritoneal epithelium, but the lower, being seen through tissue, appears grey. The nuclei are stained blue by haematoxylin. The thin layer of connective tissue between the two epithelial layers is not demonstrated.

Fig. 7. **Stratified Ciliated Epithelium** from the Nasal Cavity. (Human, aet. 22. Execution.) × **500.** The usual form of the stratified ciliated epithelium of the respiratory tract. **Technique** as for *Fig. 3.*

Fig. 8. **Glandular Epithelial Cell** from the Parotid Gland. (Human, aet. 28. Execution.) × **1500.** The protoplasm shows an apparently alveolar structure. The vacuoles contain the granular antecedents (not brought out by this method of staining) of the secretion. In the knots of the protoplasmic network are granules resembling microsomes. **Technique:** Absolute alcohol. Paraffine, very thin section. Haematoxylin-eosin.

Fig. 9. **Epithelial Cell** from a Salivary Duct. (Human, aet. 28. Execution.) × **1500.** Distinct basal filaments. While the upper part of the cell next to the lumen shows a finely fibrillar structure the basal lower part exhibits large plastosomes in rows forming rod-like structures. The cell is from the parotid gland and contains a circular nucleus with distinct nuclear network. **Technique** as for *Fig. 8.*

Fig. 10. **Four Epithelial Cells** from an Intestinal Gland. (Human, aet. 22. Execution.) × **1600.** In the middle two cells free from granules. At the ends two so-called cells of Paneth, red-staining granules fill the cytosome down to the basal part which contains the nucleus. **Technique:** Potassium bichromate—formol. Paraffine. Haematoxylin-eosin.

Fig. 11. **Granules of Mucigen** in Epithelial Cells of the Oviduct (Rabbit). × **580.** A number of cells of the simple ciliated epithelium have been caught in the process of secreting mucus, for which purpose they have lost their cilia. In the cytoplasm are seen granules which lie most closely together in the general secretion zones, the domelike upper part of the cells. The granules are the antecedents of the mucous secretion — compare the ciliated cells with those which are secreting. **Technique:** Potassium bichromate—formol. Paraffine. Haematoxylin and mucicarmine.

Fig. 12. **Secretion Granules** in the Cells of a **Serous Salivary Gland.** × **500.** The section includes six of the terminal secreting parts of the gland; their lumina are scarcely visible. The basal zone of each cell contains the nucleus and is devoid of granules which on the other hand fill the general secretion zone next to the lumen. **Technique** as for *Fig. 10.*

Fig. 13. **Intercellular Bridges Connecting Epithelial Cells.** × **800.** The preparation is from the stratum dentatum of the epidermis of the sole of the foot. **Technique** as for *Fig. 3.*

basz = basal cells
bkd = connective-tissue nuclei
bk = basal corpuscles
ci = cilia (kinocilia)
cru = crusta-like external layer
cylz = columnar cells with stereocilia
gr = granules
gr_1 = granules of rodlike structures
grz = cells with mucigen granules
ibr = intercellular bridges
k = nuclei
k_1 = nuclei of superficial cells
k_2 = nuclei of basal cells
lc = leucocytes, wandering cells
mi = mitosis
mz = middle layer of cells
nu = nucleolus
oz = layer of superficial cells
pr = protoplasm (cytoplasm)
$schl_1$ = terminal bars in longitudinal section
$schl_2$ = terminal bars in cross section
stc = stereocilia
vac = vacuolelike structures in the cytoplasm
zgr = boundaries of cells

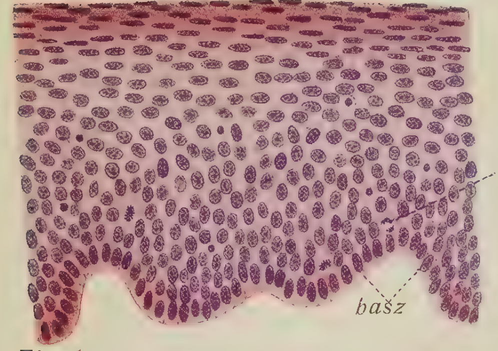

Fig. 1

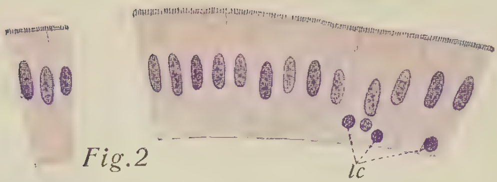

Fig. 2

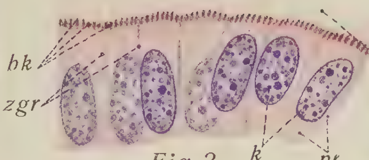
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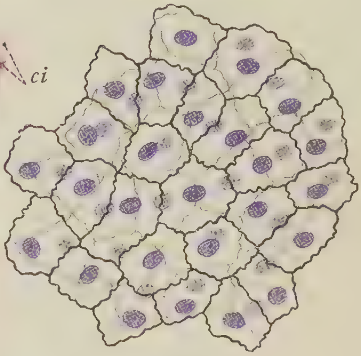
Fig. 3



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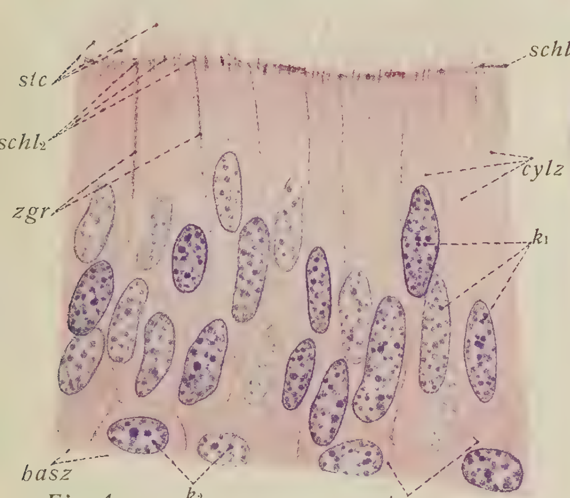
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Fig. 4

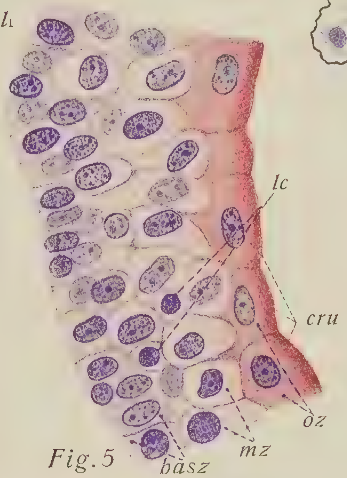
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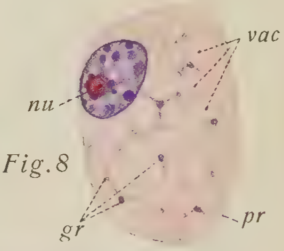
Fig. 5



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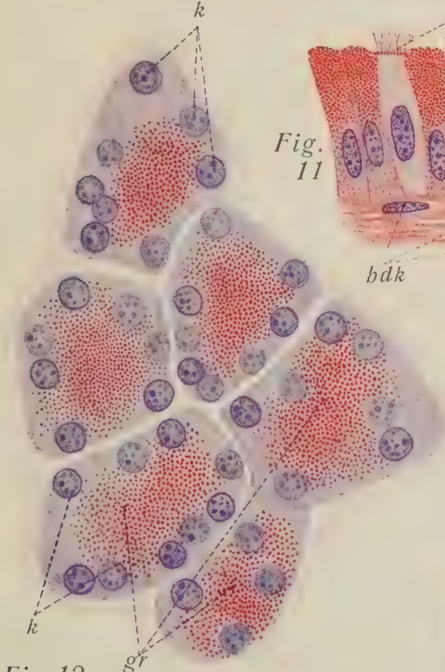
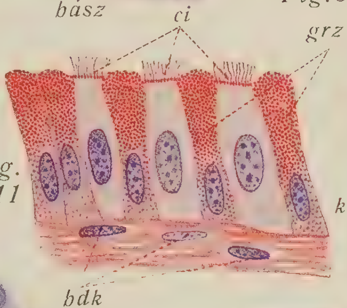


Fig. 12

Fig. 11



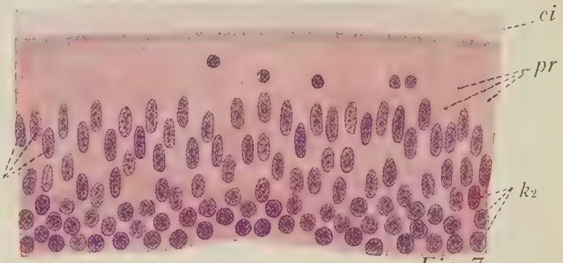
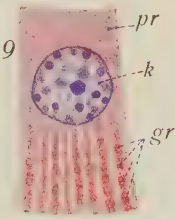
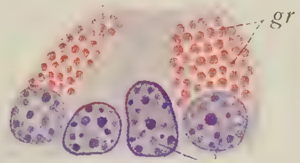


Fig. 7

Fig. 9





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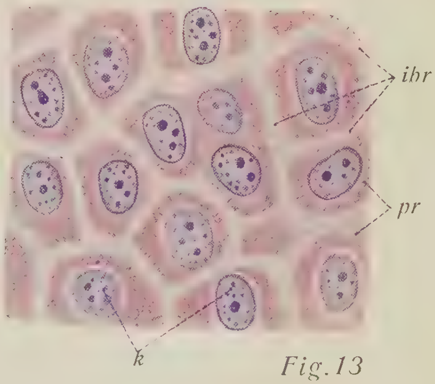

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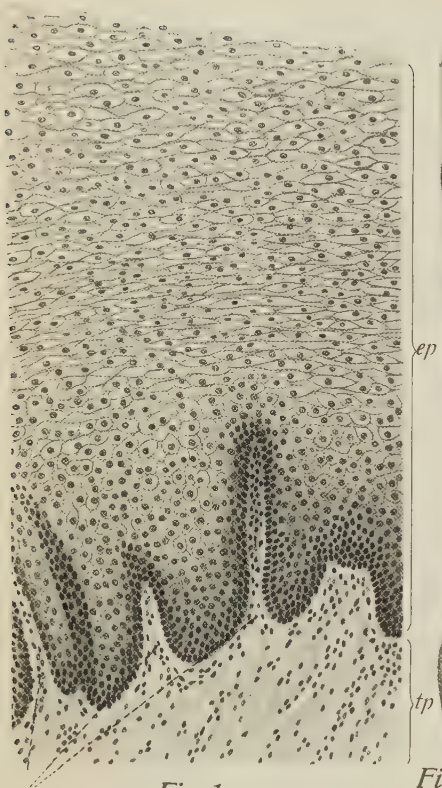

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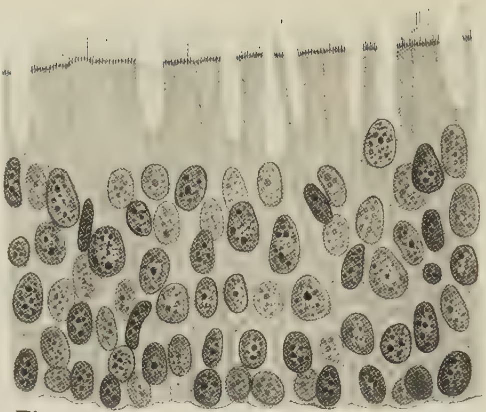

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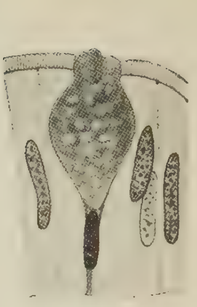

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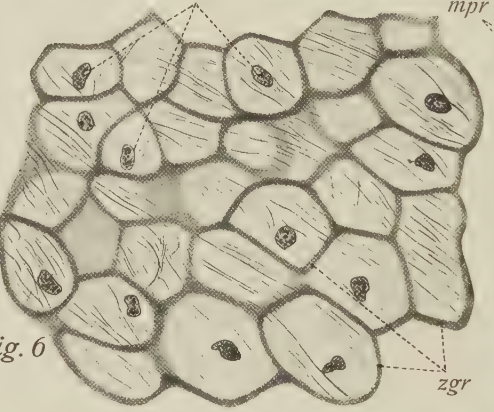

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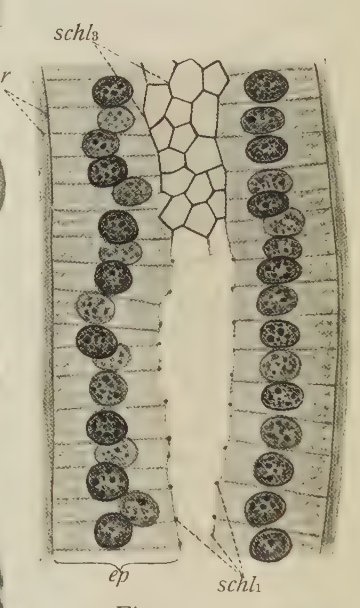
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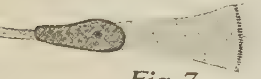
Fig. 4



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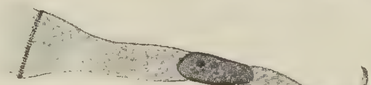

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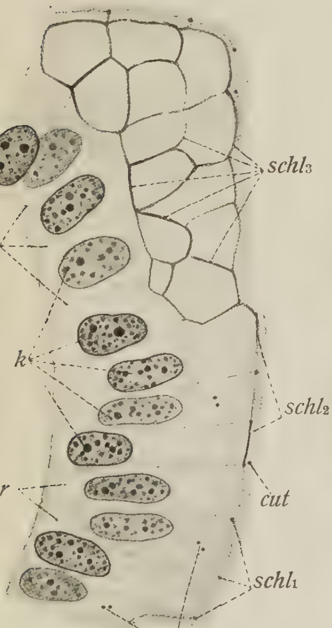
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$schl_2$
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$schl_1$
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Fig. 5

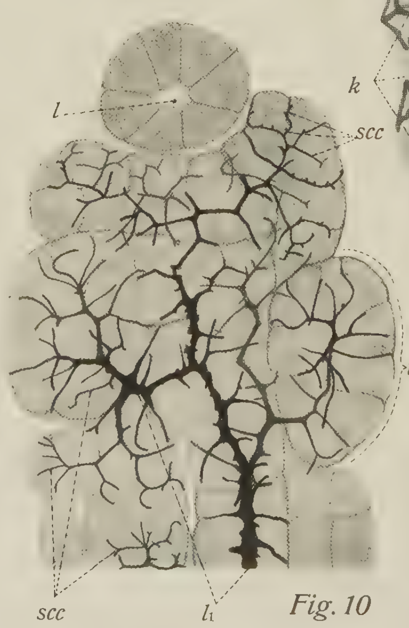
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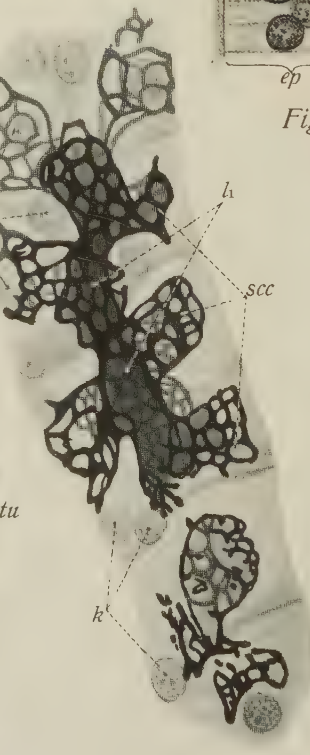
Fig. 10



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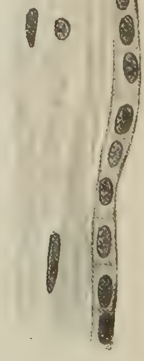

Fig. 9

Plate 4. Epithelial Tissue II.

Fig. 1. Stratified Squamous Epithelium. × 100.

An unusually thick epithelium from the mucous membrane of the lip. The epithelium is represented along with the connective tissue lying beneath, so that the papillae which in places indent the base of the epithelium for a considerable distance are clearly seen (cf. Pl. 3, *Fig. 1*). **Technique:** Zenker's Fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Stratified Ciliated Epithelium with Goblet Cells. × 800.

The preparation is from the respiratory region of the nasal cavity (cf. Pl. 3, *Fig. 7*). The mucus in the goblet cells is not stained but appears clear, like holes in the upper part of the epithelium. Distinct basal corpuscles beneath the cilia. **Technique:** Zenker's Fluid. Paraffine. Iron haematoxylin.

Fig. 3. Goblet Cell in Epithelium from the Intestine. × 800.

The cell is in the last stage of its secretory activity: near the surface is the bowl of the goblet filled with secretion; the remainder of the cell contains the pycnotic nucleus. At the sides are high columnar cells with cuticular borders and terminal bars. **Technique** as for *Fig. 2.*

Fig. 4. Simple Columnar Epithelium from a Salivary Duct. × 100.

The epithelium rests upon a distinct basal membrane (mpr); it surrounds a cylindrical lumen which in the lower two thirds is cut axially. Basal filaments show somewhat indistinctly in the basal zones of the cells (cf. Pl. 3, *Fig. 9*). Terminal bars black. **Technique** as for *Fig. 2.*

Fig. 5. **Simple Columnar Epithelium** from the Intestine. (Human, aet. 21. Execution.) × **1100.**

Striated cuticular border. Terminal bars are cut both lengthwise and across, and above where the epithelium is cut parallel to the surface they form, as it were, frames for the cells. A diplosome can be recognized in several of the cells. **Technique** as for *Fig. 2.*

Fig. 6. **Tonofibrils of the Epidermis** (Embryo calf). × **500.**

The broad, dark stained zones between the cells are intercellular spaces; they are crossed by the fibrils which appear tense. The intercellular bridges are not visible in this preparation. **Technique** as for *Fig. 2.*

Figs. 7 and 8. **Two Isolated Ciliated Cells** from a Stratified Ciliated Epithelium. × **1000.**

The conical form of the cell is characteristic, the nucleus is in a relatively basal position, the cilia have distinct basal corpuscles at their roots. **Technique:** Isolation in 33% alcohol. Haematoxylin.

Fig. 9. **Simple Squamous Epithelium.** (Human, aet. 23. Execution.) × **700.**

The preparation represents the serous epithelium of the tunica vaginalis propria testis. A simple flat-cubical epithelium rests upon underlying connective tissue. **Technique** as for *Fig. 1.*

Fig. 10. **Intercellular Secretion Canaliculi** from a Human Mixed Salivary Gland. × **300.**

Above is a so-called mucous tubulo-alveolus showing a wide lumen and no secretory canaliculi. The other tubulo-alveoli are of the serous type; their lumina are narrow and form the broader black lines. Fine branches proceed from them and lie between the cells (cf. the diagram *Fig. 7*, Vol. I). **Technique:** Potassium bichromate—osmic acid. Golgi's silver impregnation method.

Fig. 11. Intracellular Secretion Canaliculi of a Gland from the Fundus of the Human Stomach. × 1000.

The broad, dark grey zone in the middle represents the lumen. The basket-work of anastomosing secretion canaliculi is black. Since the nuclei are visible (pale grey) the intracellular position of the capillaries is clear. The cells are almost spherical in form. **Technique** as for *Fig. 10.*

centr = centrosome
cut = cuticle
ep = epithelium
k = nuclei
l = lumen (empty)
l_1 = lumen filled by precipitate of silver
mpr = membrana propria
pa = papillae

pr = protoplasm
scc = secretion canaliculi
$schl_1$ = terminal bars in cross section
$schl_2$ = terminal bars in longitudinal section
$schl_3$ = network of terminal bars
tp = tunica propria of connective tissue
tu = tubulo-alveolus
zgr = boundaries of cells

Plate 5. **Connective Tissue I.**

Fig. 1. **Connective Tissue from the Mesentery** (Rabbit). × **650.** The finely striated connective-tissue bundles are stained red. Note their different thicknesses and changing courses. Upon them lie elastic fibers of highly variable thickness stained dark violet and obviously forming a network. Only the nuclei of the cells show, the larger and paler nuclei are those of the fibrocytes; the smaller and darker nuclei those of the histiocytes. **Technique:** Zenker's fluid. Alcoholic gentian violet and safranin.

Fig. 2. **Connective Tissue from the Nasal Mucous Membrane** (Human, aet. 21. Execution.) × **550.** Connective-tissue bundles red but not very distinct. The following cells may be distinguished: 1. Fibrocytes with nuclei flattened in the direction of the bundles; the cytosome is irregular in form and the nuclei large and pale. 2. Histiocytes with smaller darker nuclei. 3. Wandering cells with lobulated nuclei. 4. Plasma cells, spherical, with eccentric "wheel" nuclei. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 3. **Dense, (Interwoven Fibrous) Connective Tissue** from the Corium of the Human Skin. × **350.** The connective-tissue bundles (red) are seen but not the elastic fibers (cf. Pl. 6, *Fig. 3*). The finely striated bundles interlace in different directions. A number of finer bundles lie parallel and close together, forming as it were thicker, secondary, bundles. The nuclei belong almost without exception to fibrocytes and are stained violet. Their relatively small number makes this variety of connective tissue poor in cells but rich in fibers. **Technique:** Müller's fluid. Celloidin, Haematoxylin-eosin.

Fig. 4. **Plasma Cell** from the Nasal Mucous Membrane. × **1350.** Cytoplasm markedly basophilic; the "wheel" nucleus is spherical, and eccentric. The cell is rounded and has a clear zone (vacuole) next to the nucleus. **Technique** as for *Fig. 2.*

Fig. 5. **Mast Cells** from Loose, Subcutaneous Connective Tissue (Mouse). × **1000.** The cytoplasm is quite filled with coarse basophile granules. **Technique:** Absolute alcohol. Ehrlich's haematoxylin.

Fig. 6. **Pigmented Connective Tissue.** (Human, aet. 28. Execution.) × **500.** From a section cut perpendicularly through the iris. Along with unpigmented connective-tissue cells are others filled with typical pigment granules of melanin. Their presence renders the processes of the cells and their form very distinct. The connective tissue is rich in cells, its fibrous elements are not shown. **Technique:** 2% Chromic acid. Celloidin. Haematoxylin-eosin.

Fig. 7. **Reticular Connective Tissue** from a Lymph Gland. (Human, aet. 28.) × **550.** The leucocytes have been shaken out of the section. There is visible a finely striated, connective-tissue framework which supports the leucocytes in the tissue of the so-called adenoid organs. Its foundation is a cellular syncytium, the nuclei of which are clearly visible. A cell larger than the others represents an element of the syncytium becoming free. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin. The section was shaken after dissolving out the celloidin.

bdb = connective-tissue bundles
bdb_1 = connective-tissue bundles cut longitudinally
bdb_2 = connective-tissue bundles cut across
bgr = basophile granulation
bz = unpigmented connective-tissue cells
elf = elastic fibers
fbc = fibrocytes
hc = histiocytes

k = nuclei
kk = nuclei of fibrocytes
kk_1 = nuclei of histiocytes
mz = reticulum cell becoming free
pbz = pigmented connective-tissue cell
plz = plasma cell
pr = protoplasm (cytoplasm)
vac = (juxtanuclear) vacuole

Tab. 5

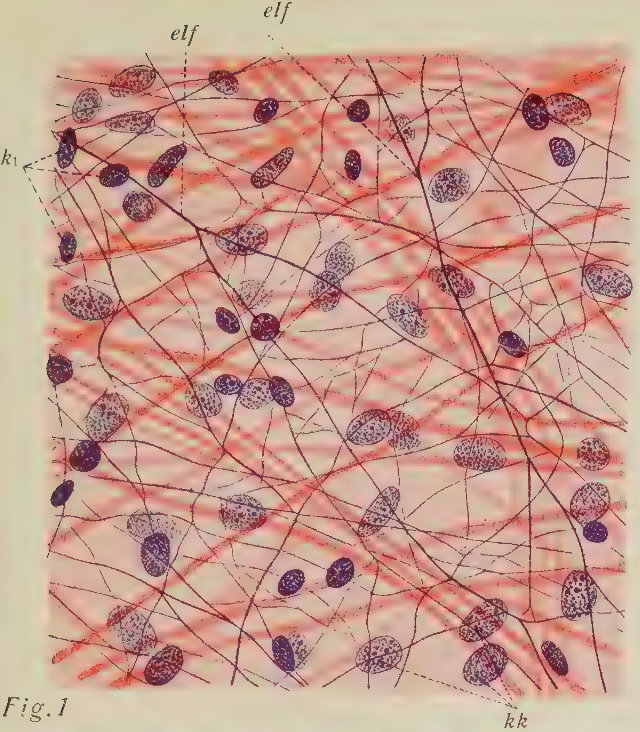
elf
elf
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Fig. 1

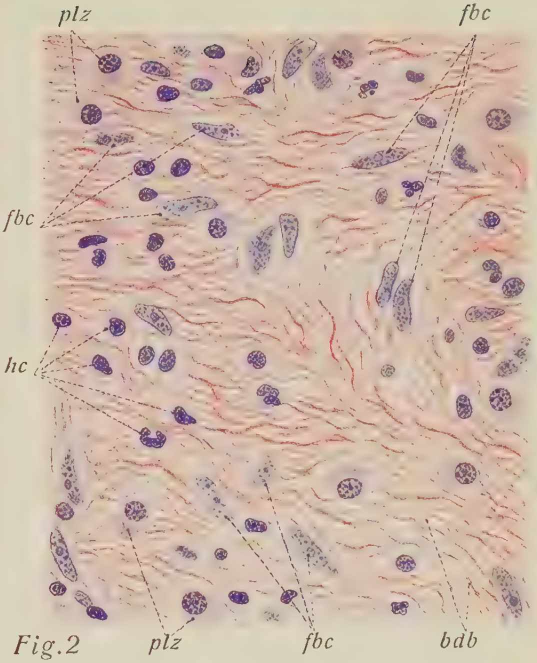
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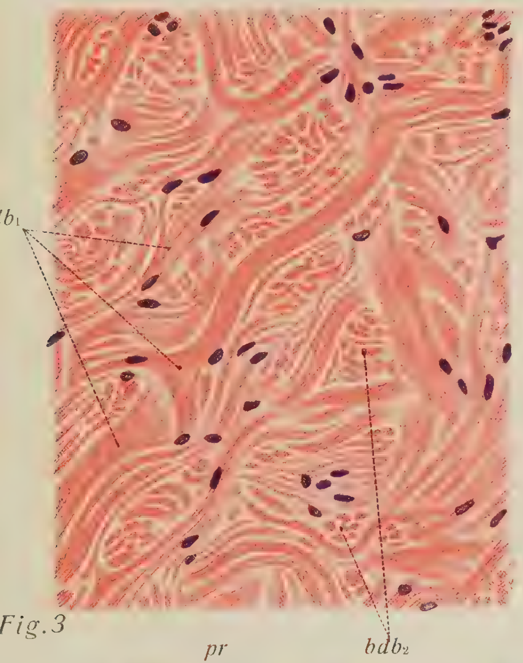
Fig. 2



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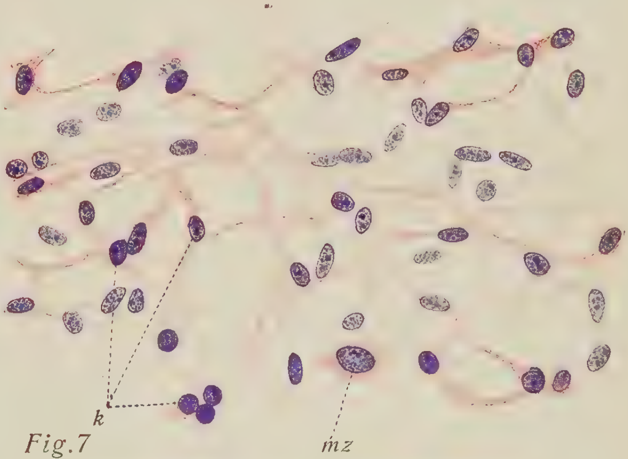

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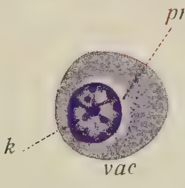

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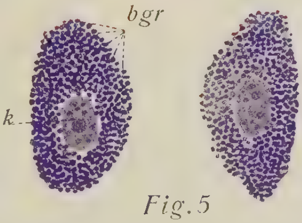

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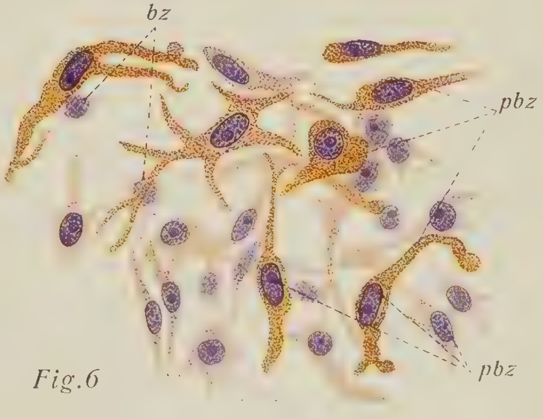
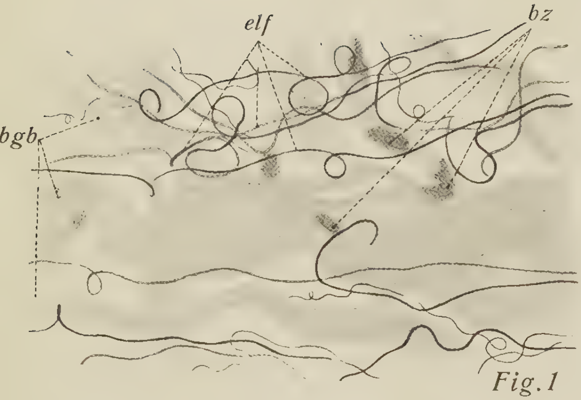


Fig. 6

Tab. 6



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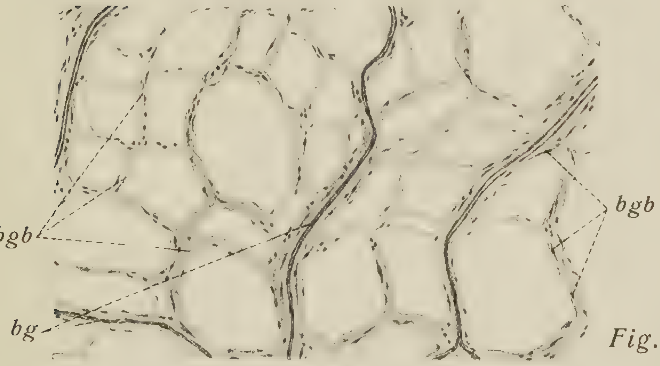
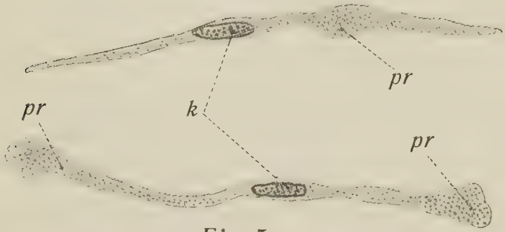


Fig. 4



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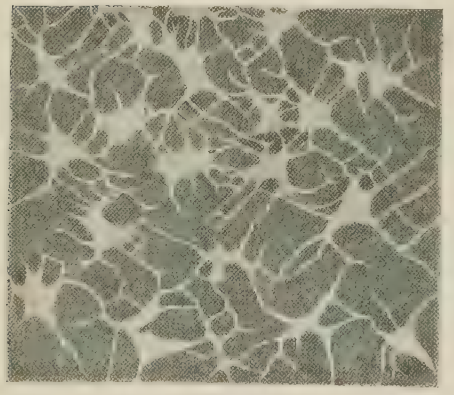

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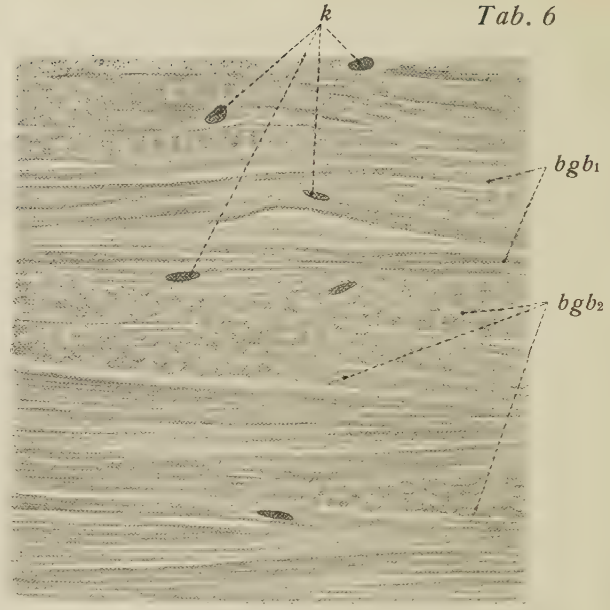

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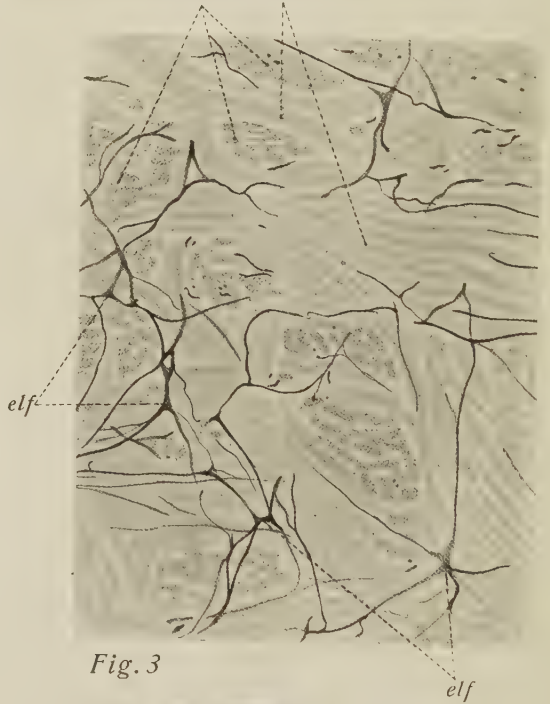
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Fig. 3

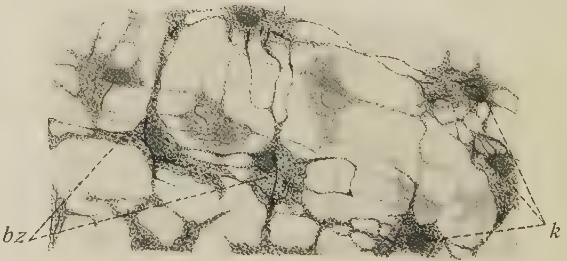

Fig. 6

Plate 6. **Connective Tissue II.**

Fig. 1. **Loose Connective Tissue.** (Human.) × **500.** Examined fresh in physiological salt solution. The finely striated connective-tissue bundles have different thicknesses and different courses. Parts of elastic fibers are also to be seen; they are mostly broken and hence have curled ends. Only a few cells are visible. The nucleus of a fibrocyte appears upon the thickest bundle; nearby are three granular histiocytes.

Fig. 2. **Formed** (Tendonlike) **Connective Tissue** from the **Sclera** of the Human Eyeball. × **600.** Cells are few and fibers abundant. Only the connective-tissue bundles and the nuclei of the fibrocytes are stained, not the elastic fibers. The bundles form layers, like lamellae, in each of which there prevails one definite direction for the bundles, so that layers cut longitudinally usually alternate with others cut across. **Technique:** 2% Chromic acid. Celloidin. Haematoxylin-eosin.

Fig. 3. **Dense, Interwoven Connective Tissue** from the Human Corium. × **400.** Compare Pl. 5, *Fig. 3.* Only the fibrous constituents, the connective-tissue bundles and elastic fibers, are represented, and not the cells. The elastic fibers form a network and vary most strikingly in thickness. The connective-tissue bundles are interwoven as in Pl. 5, *Fig. 3.* The fine collagenous fibers, or fibrils, are to be seen in the individual bundles as lines or points. The network of elastic fibers is intensely stained (hence black in the figure); the collagenous fibers are quite faint (grey in the figure). **Technique:** Müller's fluid. Celloidin. Acid orcein.

Fig. 4. **Areolar Connective Tissue** from the Human Great Omentum. × **90.** The connective-tissue bundles are of highly variable diameter; they anastomose forming a network of wide meshes. The finest bundles contain no fibrocytes; small blood vessels run in the coarser strands. **Technique:** Müller's fluid. Haematoxylin-eosin.

Fig. 5. **Two Histiocytes (Clasmatocytes)** from the Human **Omental Connective Tissue.** × **750.** The cells have a greatly extended form, a relatively small nucleus rich in chromatin (dark). The ends are swollen and clublike and the cytoplasm contains distinct granules. **Technique** as for *Fig. 4.*

Fig. 6. **Fixed Corneal Cells,** from a Tangential Section of the Cornea. (Rabbit.) × **360.** Flat and abundant fibrocytes with relatively regularly branched fibrocytes form nets in the typical manner (connection by continuity). Cells in different planes are visible. The nuclei appear indistinct because in the protoplasm are fine granules (mitochondria ?) and fibrils (tonofibrils ?) which are stained, and obscure the nuclei. Connective-tissue fibers not visible. **Technique:** Gold chloride. Celloidin.

Fig. 7. **Cell Spaces (Negative Picture) in the Connective Tissue of the Cornea (Frog.).** × **200.** The fibrous mass of the tissue is stained dark by the action of the silver. The spaces which contain the cells (not shown) appear clear as also do the anastomosing canaliculi. The forms of the cells may be deduced from the forms of the spaces and canaliculi since both of the latter are entirely filled by the cells. **Technique:** Silver nitrate. Reduction by light.

bg = blood vessels
bgb = connective-tissue bundles
bgb_1 = connective-tissue bundles cut longitudinally
bgb_2 = connective-tissue bundles cut transversely
bz = connective-tissue cells
elf = elastic fibers
k = nuclei
pr = protoplasmic (cytoplasmic) thickening of histiocytes with granules

Plate 7. **Connective Tissue III.**

Fig. 1. **Adipose Tissue** from the Orbit of the Human Eye. × **200.** Typical fat cells with needles of fatty acids in the large fat droplets which occupy almost the entire cell. The droplets have not been dissolved out of the cells because the preparation was not passed through any fat-dissolving reagent. The flattened nuclei, lying against the so-called membrane, contain fat droplets (perforated nuclei). **Technique:** Zenker's Fluid. Haematoxylin-eosin. Teased preparation.

Fig. 2. **Adipose Tissue from the Tela Subcutanea** of the Human Skin. × **400.** The typical picture of empty fat cells and their so-called membranes resulting from the use of reagents which dissolve fat. Only the membranes and the flattened nuclei are recognizable; clear spaces are left where the fat drops are dissolved. A very little connective tissue lies between the flattened-spherical fat cells. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 3. **Fat Cells** from the Broad Ligament (Mouse). × **600.** The fat is blackened by fixation in osmic acid and remains undissolved. The large fat cells differ in size and lie within ordinary fibrillar connective tissue. In addition to the black fat droplet only the nucleus and a little neighboring cytoplasm are seen; in this case the nucleus has no vacuole. This picture corresponds to the actual structure of the fat cell far more than does *Fig. 2.* **Technique:** Chrom-osmo-acetic acid. Paraffine. Iron haematoxylin.

Fig. 4. **An Elastic Plate (Fenestrated Membrane)** from the Wall of the Human Aorta. × **800.** By the fusion of flat elastic fibers an elastic plate has been formed in which are numerous holes, mostly small. Here and there individual fibers may still be recognized. **Technique:** Müller's fluid. Teased preparation.

Fig. 5. **Gelatinous Connective Tissue from the Umbilical Cord** of a New-born Infant. × **450.** Within a ground substance lie the relatively few and scattered bundles of collagenous fibers. There is seen distinctly a network of clear-cut fibrocytes of spindle or stellate form. **Technique:** Chrom-osmo-acetic acid. Celloidin. Iron haematoxylin.

Fig. 6. **Reticular Connective Tissue** from a Human Lymph Gland. × **500.** Demonstration of the reticulum fibers by silver-impregnation. Fibers of varying diameters are to be recognized which divide frequently and at last run into a lattice of extremely fine fibers. They represent the fibrous portion of reticular connective tissue (cf. Pl. 5, *Fig. 7*). The pale round nuclei of the lymphocytes of adenoid tissue are also visible. **Technique:** Formol. Frozen section. Bielschowsky's silver method.

bd = connective tissue
bdk = connective-tissue nuclei
bg = blood vessel
f_1 = coarse reticulum fibers
f_2 = division of coarse into finer fibers
f_3 = extremely delicate reticulum fibers
fe = fat droplets
fm = fat-cell membrane

k = nuclei of lymphocytes
kfe = nuclei of fat cells
kfe_1 = nucleus of fat cell seen from the surface
kfe_2 = nucleus of fat cell seen from the edge
kr = crystals (needles) of fatty acids
kvac = vacuole in nucleus of fat cell
z = fibrocytes of gelatinous connective tissue
zf = processes of cells

Tab. 7

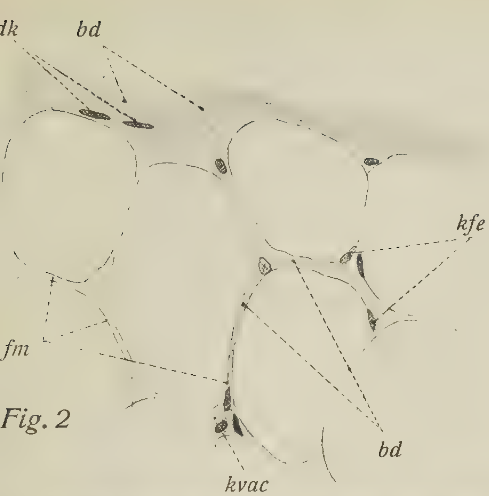
dk
bd
kfe
fm
bd
kvac

Fig. 2

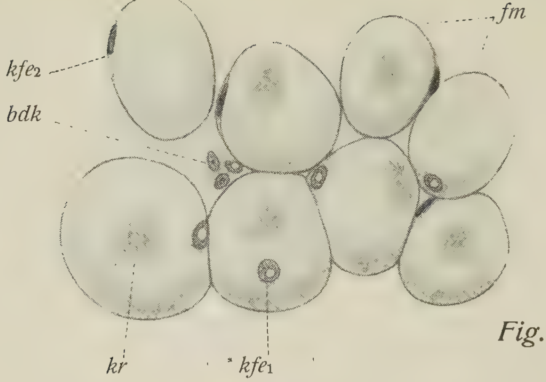
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Fig. 1

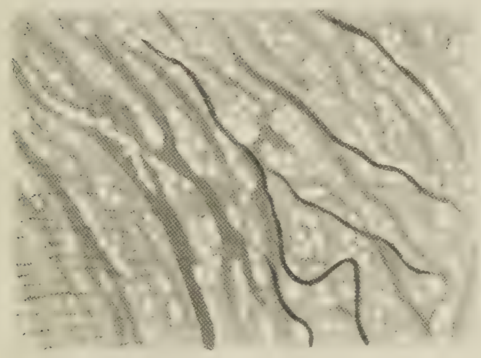


Fig. 4

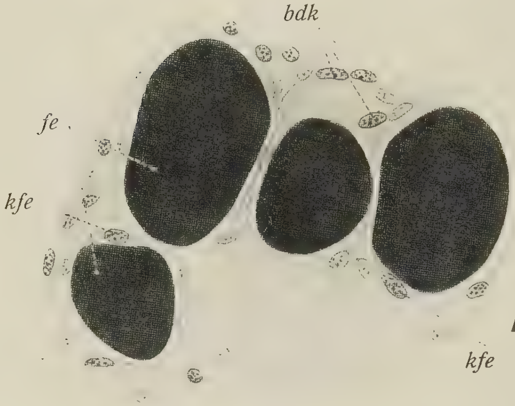

bdk
fe
kfe
kfe

Fig. 3

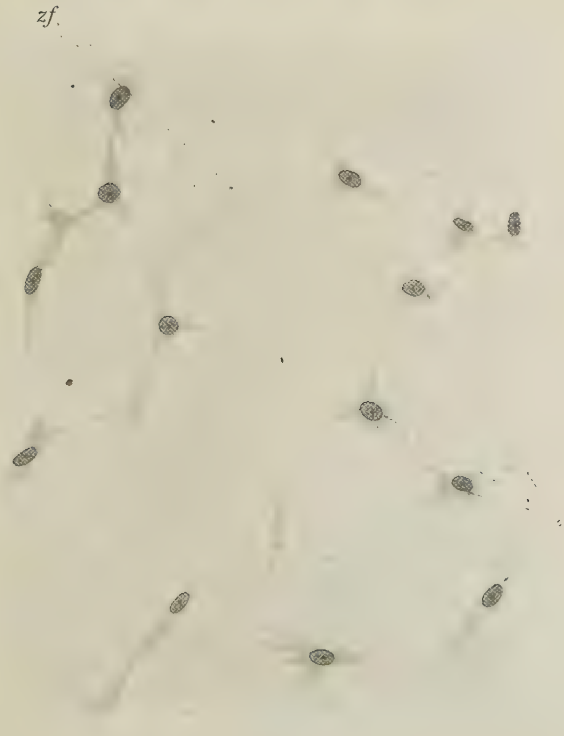
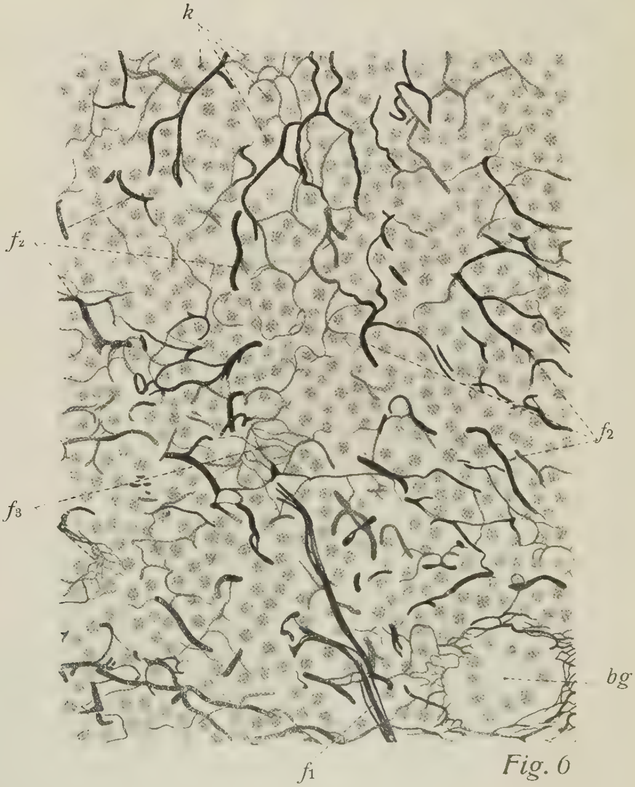


Fig. 5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f2
f2
f3
bg
f1

Fig. 6

Tab. 8

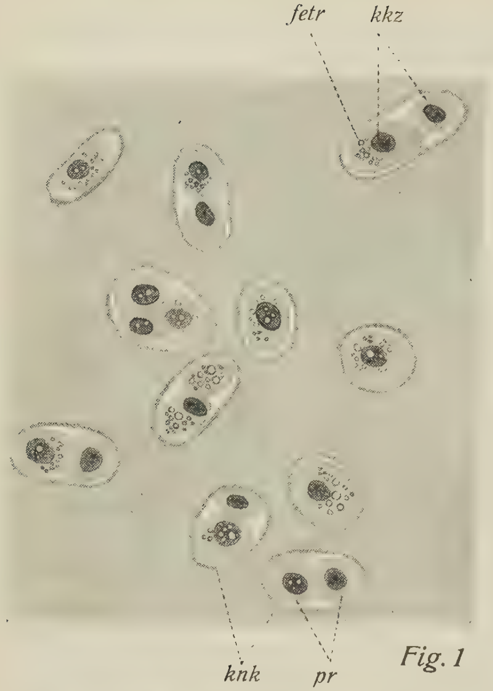
fetr
kkz
knk
pr

Fig. 1

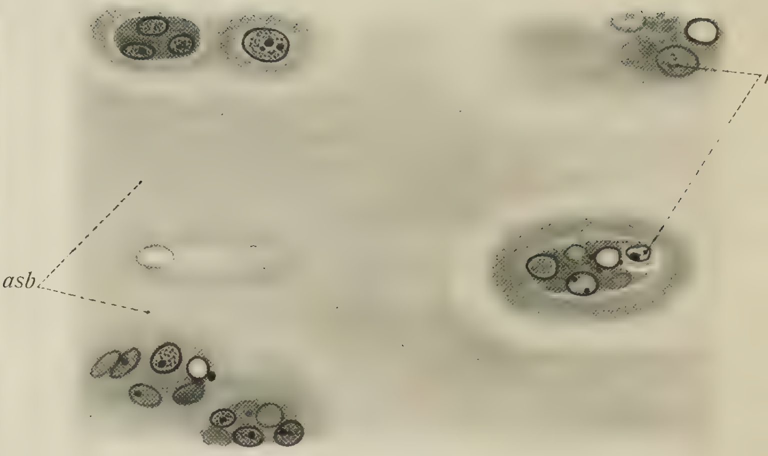

Fig. 2

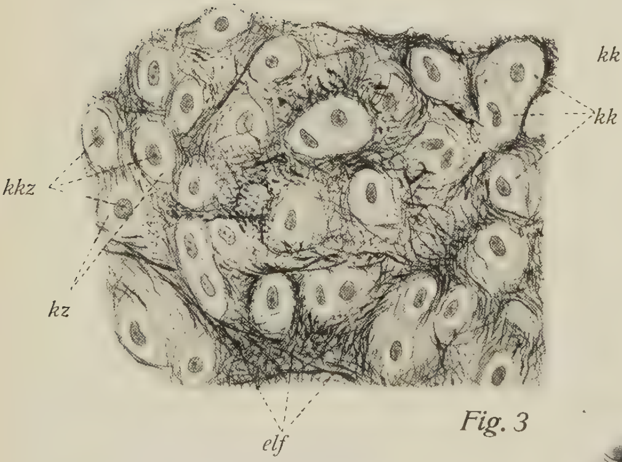
kk
kkz
kz
elf

Fig. 3

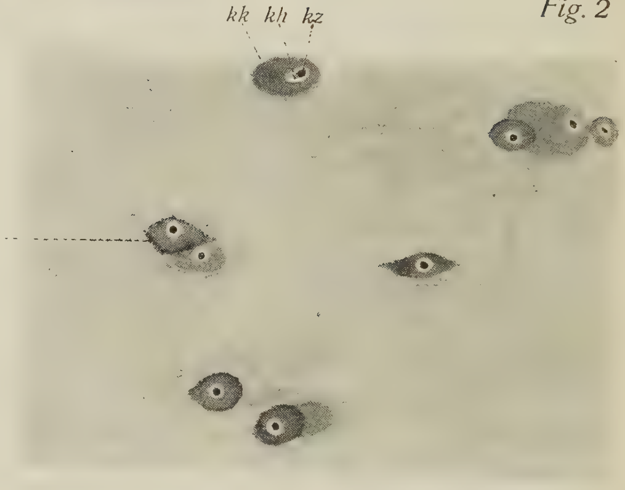

Fig. 4

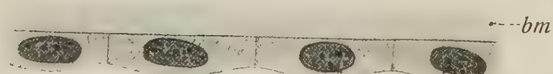

Fig. 5

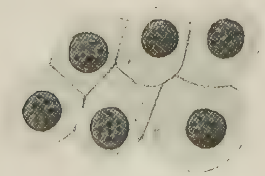

Fig. 6

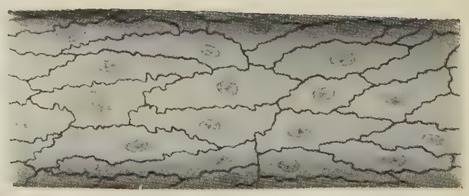

Fig. 7

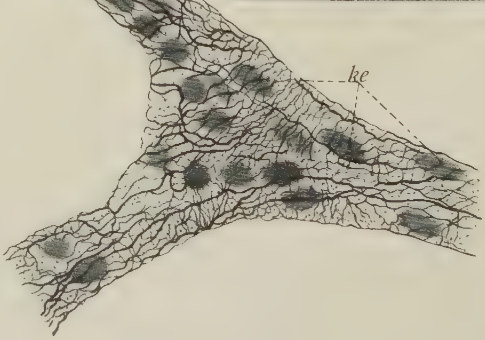

Fig. 8

Plate 8. **Cartilage I. Endothelium.**

Fig. 1. Part of a Section of the Cartilage of a Rib (Youth). × **280.** Examined fresh in physiological salt solution. Typical **Hyaline Cartilage** with cartilage capsules and lacunae; within the latter are from one to three cells. Cytoplasm and the nuclei show fine fat droplets.

Fig. 2. Part of a Section through the Central Region of the **Cartilage of a Rib** (Adult). × **250.** Hyaline Cartilage with its matrix looking like mineral asbestos because of degeneration. The cartilage here contains but few cells which to a great extent lie in nests, so-called chondrones. Outside of the clear cartilage capsule is a dark inner and a clear outer zone of matrix surrounding the chondrone. An **Asbestos-like Fibrillation** appears in the matrix where the latter is free from cells. **Technique:** Alcohol. Freehand section. Haematoxylin.

Fig. 3. Part of a Section from the Cartilage of an Ear. **Elastic Cartilage.** (Human, aet. 22. Execution.) × **220.** Cartilage cells and capsules lie within a network of fine elastic fibers which stain dark and almost fill the matrix. **Technique:** Zenker's fluid. Celloidin. Weigert's method for elastin.

Fig. 4. Part of a Section of a Human Intervertebral Disc. **Fibro-cartilage.** × **180.** Within a dense fibrous connective tissue, free from cells, there lie isolated cartilage capsules with their cells (small chondrones). **Technique** as for *Fig. 2.*

Fig. 5. **Endothelium** from the Posterior Surface of the Human **Cornea.** × **1200.** From a meridional section through the eyeball. Endothelial cells of connective-tissue origin form the posterior layer of the cornea. They are flat-cubical, resemble exactly a simple epithelium and rest upon a layer of connective tissue as though upon a basal membrane. **Technique:** 2% Chromic acid. Celloidin. Haematoxylin-eosin.

Fig. 6. **Tangential Section through the Corneal Endothelium.** × **800.** Epithelium-like arrangement of cells. Cell boundaries. **Technique** as for *Fig. 5.*

Fig. 7. **Endothelial Lining** of a Small Artery from the Bladder (Frog). × **375.** The elongated form of the endothelial cells may be recognized, and the lines of cement (black) running between them in wavy courses. The nuclei of the cells seem clear. **Technique:** Injection with silver-gelatine. Reduction of the silver chloride by light. Haematoxylin.

Fig. 8. Blood Capillary from the Cerebrum. **Endothelium and Reticulum Fibers.** × **900.** Of the endothelium only the somewhat faded nuclei are to be seen. On the other hand the closely woven network of reticulum fibers is clearly recognized forming the basal membrane of the capillary wall. The endothelium and its nuclei lie within the network of fibers. **Technique:** Formol. Celloidin. Bielschowsky-Studnicka method of silver impregnation.

asb = asbestos-like fibrous matrix
bm = basal membrane
fetr = fat droplets
elf = network of elastic fibers
ke = nuclei of endothelium
kh = lacunae in cartilage
kk = cartilage capsules
kkz = nuclei of cartilage cells
knk = cartilage capsules
kz = cartilage cells
pr = protoplasm (cytoplasm)

Plate 9. **Connective Tissue IV. Cartilage II. Bone.**[1]

Fig. 1. **Dense Fibrous Connective Tissue, Tendinous Tissue.** Section across a Tendon (Tail of Mouse). × **700.** A small tendon is seen ensheathed by the so-called peritendineum formed of layers of fibrous connective tissue. The tendon is composed of a single secondary tendon bundle. Within it the primary bundles formed of collagenous fibers alone appear red and quite homogeneous; between them lie the tendon cells. Fine processes extend from the part of the cell which contains the nucleus (wing cells). The processes more or less completely separate the bundles of the tendon from one another. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. **Wing Cells from a Tendon** (Tail of Mouse). × **1100.** Flat fibrocytes, arranged in rows, with regular flattened processes. Each cell has as a rule four processes projecting at right angles, which embrace the primary bundles of the tendon. The processes lie in pairs in two planes, one plane is that of the preparation, the other is perpendicular to it; one of the processes in the latter plane shows as the clear stripe across the nucleus. The elongated, flat nuclei of neighboring cells lie close together in pairs (cf. Diagram *Fig. 10*, Vol. I). Beneath are two cells with their nuclei viewed edgewise. **Technique:** Haematoxylin. Glacial acetic acid. Ammonia. Prepared by crushing.

Fig. 3. **Elastic Tissue.** Transverse Section of the **Ligamentum Nuchae** of an Ox. × **250.** Stout elastic fibers (yellow) of somewhat variable thickness lie parallel and are cut across. About them is a small amount of connective tissue (red) containing nuclei. **Technique:** Alcohol. Celloidin. Van Gieson's picro-fuchsin and haematoxylin.

Fig. 4. **Hyaline Cartilage.** Part of a Transverse Section of a **Human Tracheal Cartilage.** × **200.** Above lies the connective tissue perichondrium; beneath it is the border zone of the cartilage with numerous small cells and oxyphile (red) matrix passing into the perichondral connective tissue. Then follows the zone in which the matrix gradually becomes basophile (blue) and the cells larger and less frequent. Below are chondrones in rows (Pl. 8, *Fig. 2*) and between the rows stout bars of matrix. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 5. **Bone Tissue.** From a Human Metacarpal Bone. × **740.** The cells of the bone are to be seen with their nuclei, and with many of their long processes lying in the well marked canaliculi. Note also the lines of cement between the lamellae (see Pl. 20). **Technique:** Alcohol. Decalcification in 5% trichloracetic acid. Delafield's Haematoxylin and borax carmine. Mounted in M. Heidenhein's alcoholic glycerine jelly.

Fig. 6. **Bone Tissue** (Human Nasal Turbinate Bone). × **800.** Four lacunae are to be seen in the matrix which appears quite homogeneous; within each lacuna lies a much shrunken cell. The very delicate processes of the cell have been greatly injured, as is usual in fixed and decalcified preparations, and only suggestions of them are visible. Like the whole cell they have retracted so that the canaliculi appear empty. **Technique** as for *Fig. 4.* Decalcification with dilute hydrochloric acid.

bb = connective-tissue bundles (primary bundles)
bd = connective tissue between the elastic fibers
cho = chondrone
elf = elastic fibers
hk = Haversian canals
k = nuclei of wing cells
k_1 = nuclei of connective-tissue peritendineum
k_2 = nuclei of tendon cells
kgr = bone matrix
kk = nuclei of bone cells
knh = lacunae
knz = bone cells
la = lamella of bone matrix
pr = protoplasm (cytoplasm)
z_1 = zone of oxyphile matrix
z_2 = zone of basophile matrix and its arrangement in bars
+ = 3 canaliculi opening into the Haversian canal
* = wing process perpendicular to the plane of the plate
** = intervals between cells

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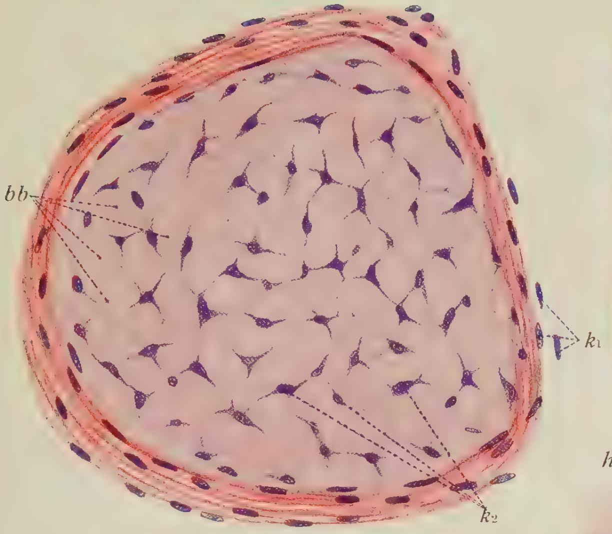
[1] See also Plates 19 and 20.

Tab. 9



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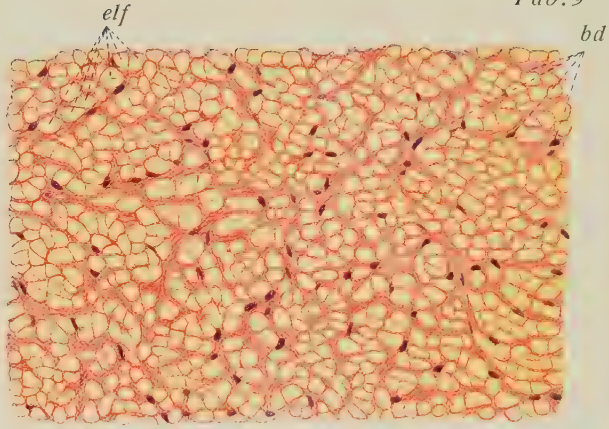

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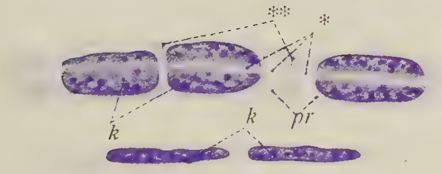

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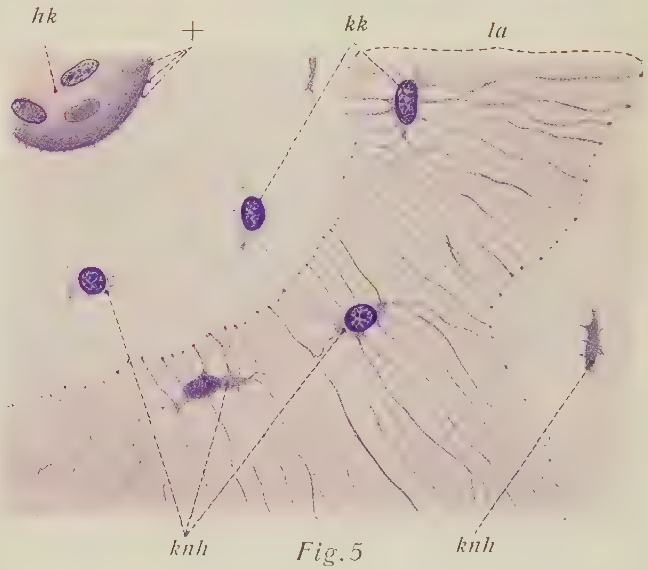
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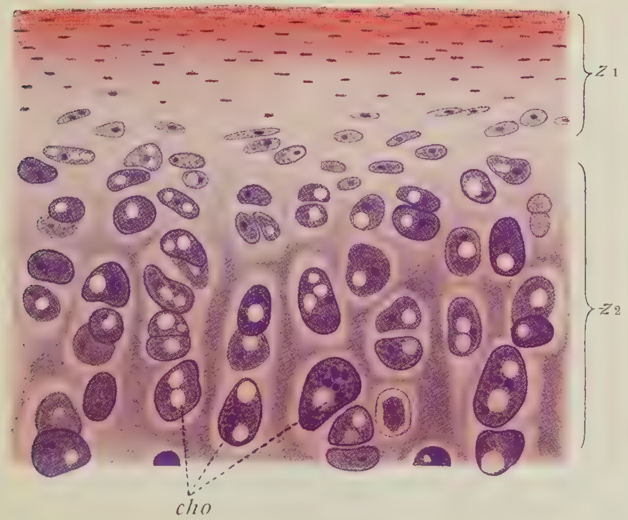
Fig. 5



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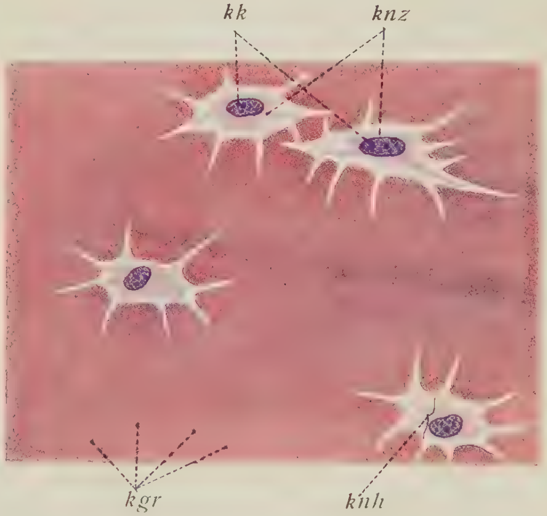
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Fig. 6

Tab. 10

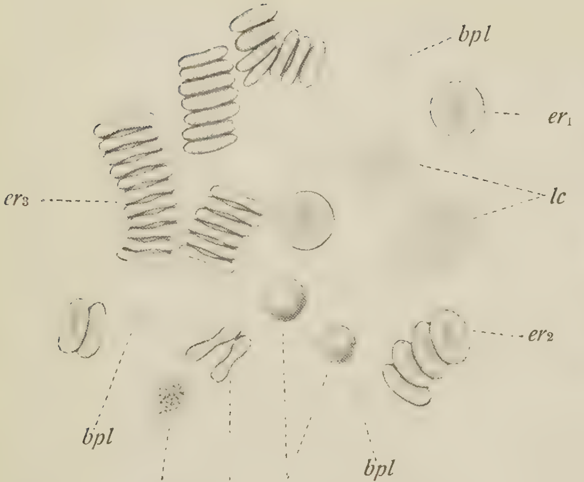
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Fig. 1

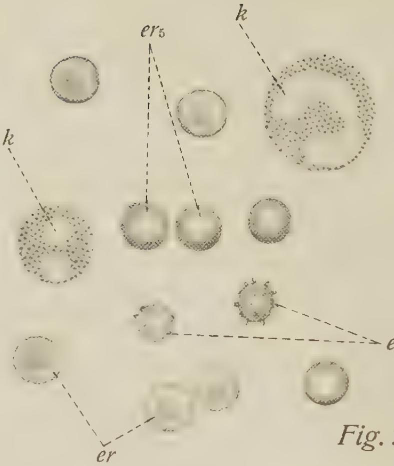
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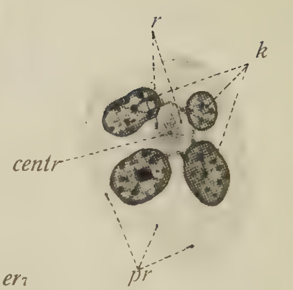
Fig. 2



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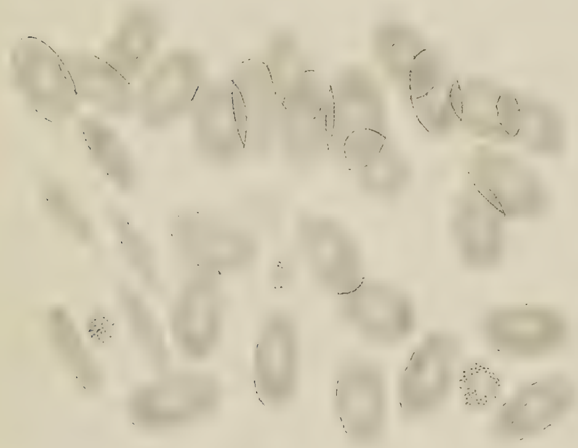

Fig. 3

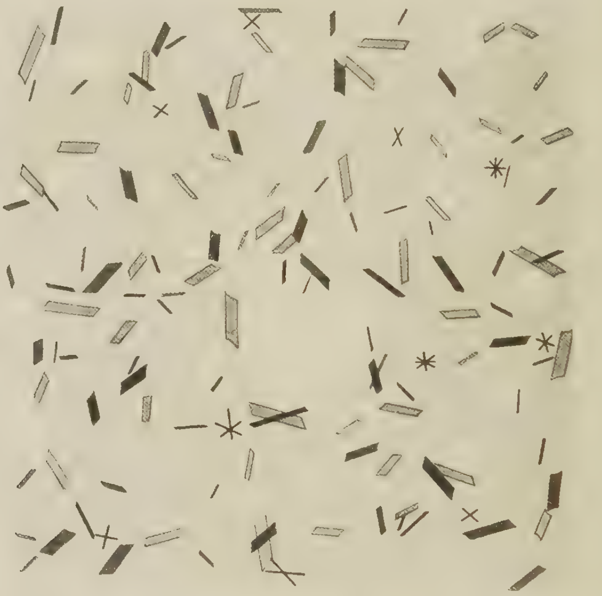

Fig. 5

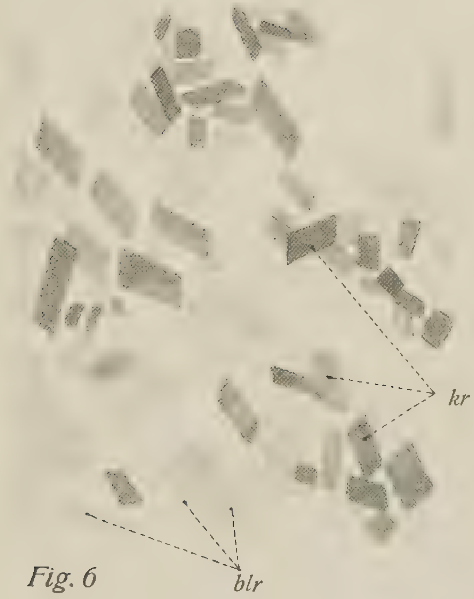

Fig. 6

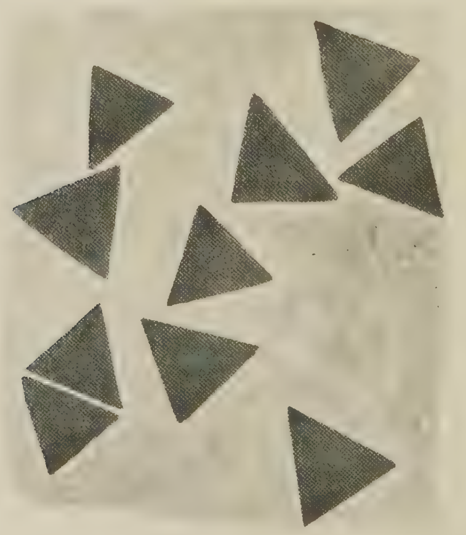

Fig. 7

Plate 10. Blood I.

Figs. 1 and 2. **Fresh Human Blood.** × **1000.** In *Fig. 1* erythrocytes, colorless blood cells and platelets are to be seen, in *Fig. 2*, only erythrocytes and two coarsely granular, colorless blood cells. Many of the erythrocytes in *Fig. 1* have formed rouleaux, others are seen in surface view or edgewise; some of the forms are abnormal, at the lower right is a bell-shaped erythrocyte, others are spherical or abnormally small. The colorless blood cells of *Fig. 1* appear as finely granular, irregularly spherical masses of protoplasm; their nuclei do not show. The platelets appear as irregularly spherical discs. In *Fig. 2* there are to be seen two erythrocytes which show many projecting points due to shrinkage. Both of the leucocytes represented in this figure are coarsely granular, consequently the polymorphous nuclei are visible as clear areas.

Fig. 3. **Fresh Blood (Frog).** × **400.** Nucleated erythrocytes are seen in surface view (as elliptical discs) and also in profile (the addition of a small amount of water has rendered the nucleus clearly visible). Among the erythrocytes are a few scattered colorless blood cells, more or less distinctly granular, rounded, or irregular from amœboid movement. Note the large size of the erythrocytes, their elliptical form and the nuclei (all vertebrates except mammals have nucleated erythrocytes). The colorless blood cells also, although smaller than the red, are larger than in man (*Figs. 1 and 2* × 1000, *Fig. 3* × 400).

Fig. 4. **Leucocyte (Salamander Larva).** × **1000.** The finely granular protoplasmic body of the cell is quite bare; within is seen a highly polymorphous nucleus, the four main parts of which are joined into a ring by slender bridges of chromatin. Within the nuclear ring lies the centrosome with a distinct aster. Note the large size of the cell; the Amphibia, particularly the Urodela, have far larger cellular elements than man. **Technique:** 2% Chromic acid. Preparation from the lung. Haematoxylin-eosin.

Figs. 5—7. So-called **Blood Crystals.** *Fig. 5* shows the **Haemin Crystals** so easily obtained from blood; they show in large numbers in the preparation as dark brown rhombic needles, often crossing one another. × **800.** *Fig. 6* shows the only form of crystal spontaneously assumed by the red coloring matter of the blood. These **Haematoidin Crystals** are rhombic plates, larger than the haemin crystals and paler, being yellowish red in color. The preparation is from a pathological effusion. × **500.** *Fig. 7* shows the large massive **Crystals of Haemoglobin.** × **300.** The preparation is from the guinea-pig, the haemoglobin of which crystallizes relatively easily in the form of brilliant, dark red, regular four-sided prisms. The figure shows the basal surfaces of the prisms.

blr = remains of blood clot
bpl = platelets
centr = centrosome
er = erythrocytes
er_1 = ordinary form of disc with concavity
er_2 = rouleaux in process of formation
er_3 = typical rouleaux
er_4 = view in profile
er_5 = abnormal, spheroidal forms
er_7 = shrunken forms
k = nucleus
kr = crystals
lc = leucocytes
pr = protoplasm
r = aster

Plate 11. **Blood II. Bone Marrow.**

Fig. 1. **Stained Dry Preparation of Human Blood.** × **950.** In the middle are three polymorphonuclear leucocytes with neutrophilic granulation, to the right and above a lymphocyte much smaller; elsewhere are erythrocytes and groups of platelets. **Technique:** Dry cover-glass preparation. Alcohol-ether. May-Grünwald method of methylene blue—acid eosin.

Figs. 2—16. Elements of **Human Blood.** *Fig. 2,* × **700.** *Fig. 3—16,* × **1100.** *Fig. 2* shows surface views of four erythrocytes, that on the left has a pycnotic nucleus. *Figs. 3—16* different forms of colorless blood corpuscles. *Fig. 3* small lymphocyte. *Figs. 4 and 5* lymphocytes of larger size. *Figs. 6—10* polymorphonuclear leucocytes, the neutrophilic granulation is not brought out by the stain here used. *Fig. 11* large mononuclear leucocyte. *Figs. 12—14* different forms of eosinophile leucocytes. *Figs. 15—16* basophile leucocytes. **Technique:** Smear and fixation as for *Fig. 1.* Haematoxylin-eosin.

Fig. 17. **Platelets of Human Blood.** × **1000.** Six platelets of different sizes; the nuclei (?) appear almost pycnotic. **Technique:** Washing with Detjeen's amylene-peroxide—salt solution. Osmic acid. Giemsa's stain.

Fig. 18. Section of Red **Bone Marrow** from the Centrum of a Vertebra. (Child, aet. 4.) × **80.** General view of red marrow. Numerous blood vessels (venous capillaries) densely filled with blood are to be seen; also marrow cells; among which large giant cells are scattered at rather regular distances. A small piece of the spongy bone also appears. **Technique:** Zenker's fluid. Decalcification by nitric acid. Celloidin. Haematoxylin-eosin.

Fig. 19. Giant Cells **(Megakaryocytes).** × **1000.** From the same preparation as *Fig. 18.* The massive protoplasmic body of these large cells is to be seen, also the nucleus which is incompletely broken up into lobules and often is of ringlike form.

Fig. 20. Part of a Section of Red **Bone Marrow** from the Epiphysis of the Human Femur. × **1000.** There are to be seen four erythroblasts with pycnotic nuclei, four ordinary erythrocytes, four finely granular neutrophile myelocytes, one myeloblast without granulation, one eosinophilic myelocyte, and one mast cell (basophilic myelocyte). **Technique:** Sublimate. Paraffine, thin section. May-Grünwald polychromatic methylene blue.

bmc = basophilic marrow cell
bpl = platelets
cap = capillaries of the marrow
emc = eosinophilic marrow cell
er = erythrocytes
erbl = erythroblasts
k = nucleus of megakaryocyte
kn = bone

lyc = lymphocyte
mbl = myeloblast
mc = myelocyte with neutrophilic granulation
mz = marrow cells
ntlc = leucocytes with neutrophilic granulation
pr = protoplasm of giant cell
rz = giant cells

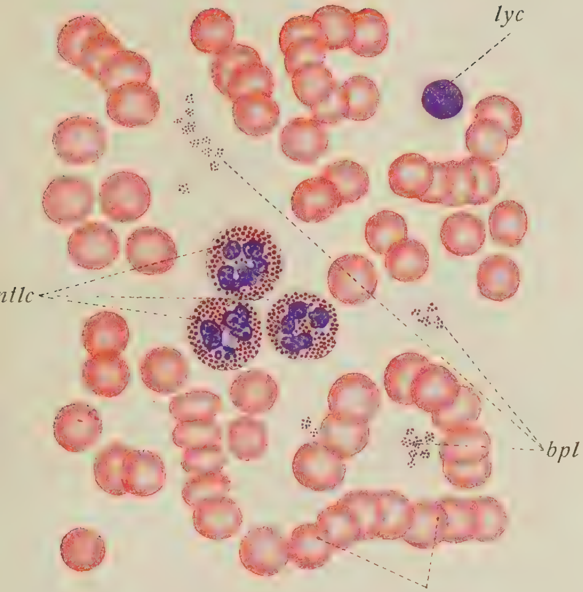
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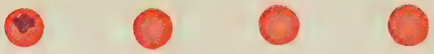
Fig.1



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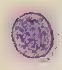

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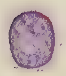

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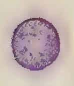

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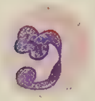

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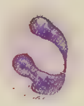

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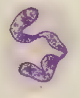

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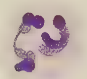

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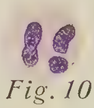

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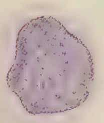

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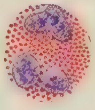

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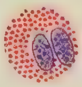

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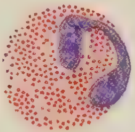

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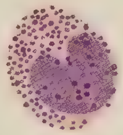

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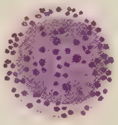

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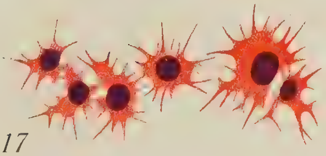

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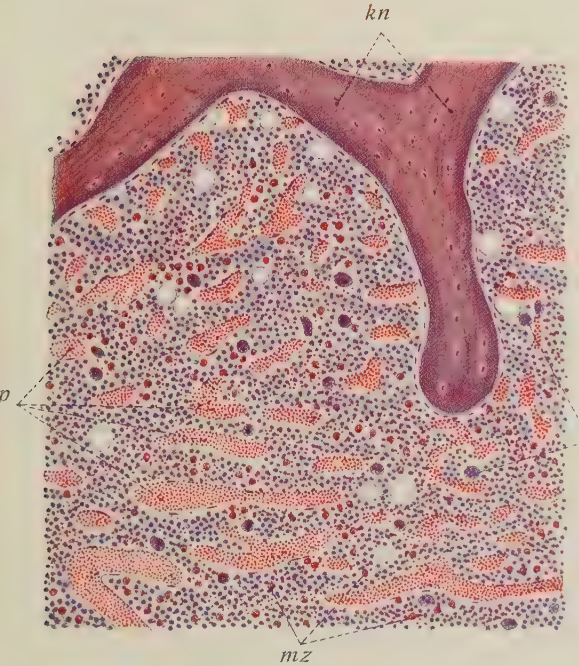

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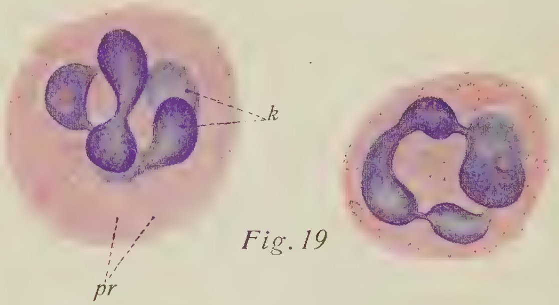

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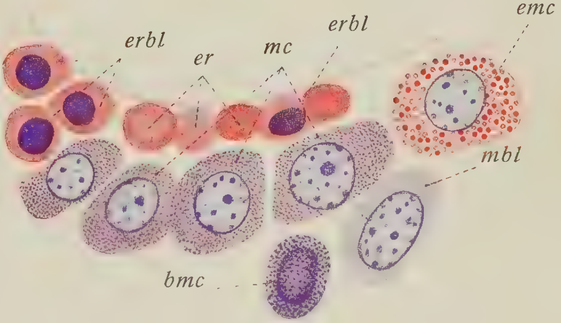
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Fig. 20

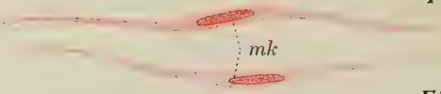
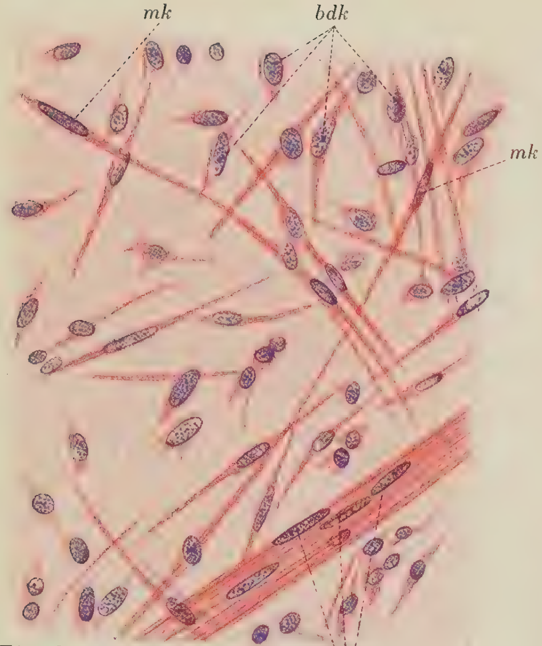


Fig. 1



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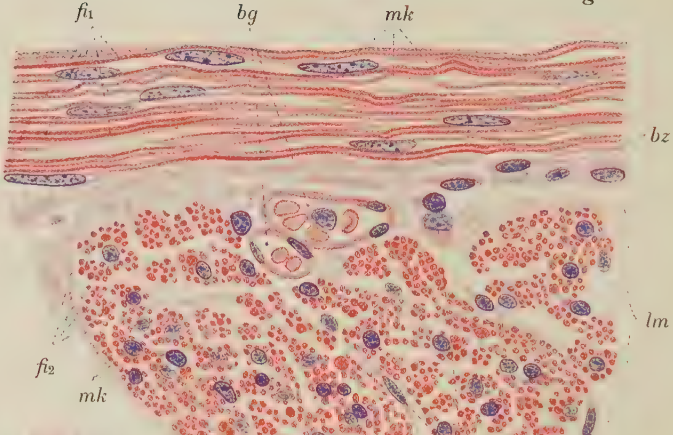
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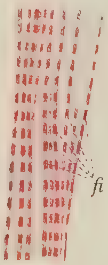
Fig. 3



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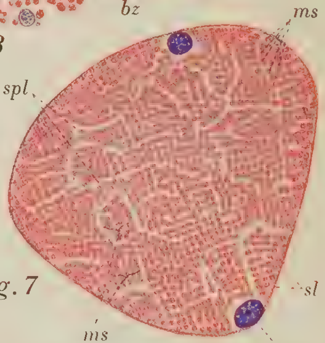
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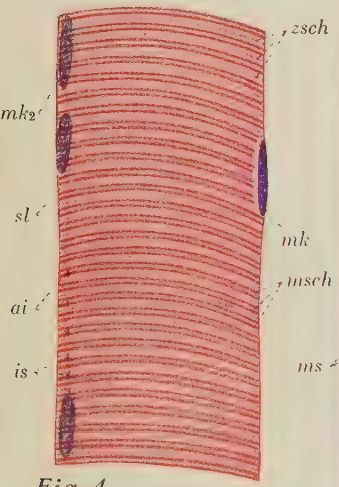
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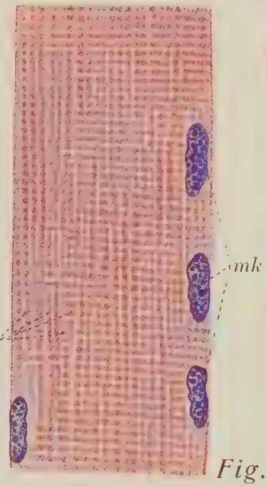
Fig. 4



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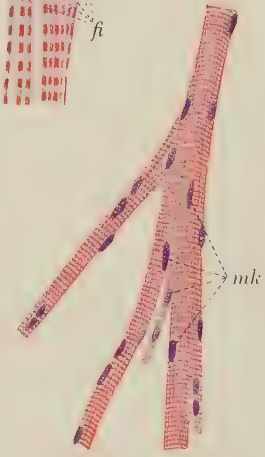

Fig. 8

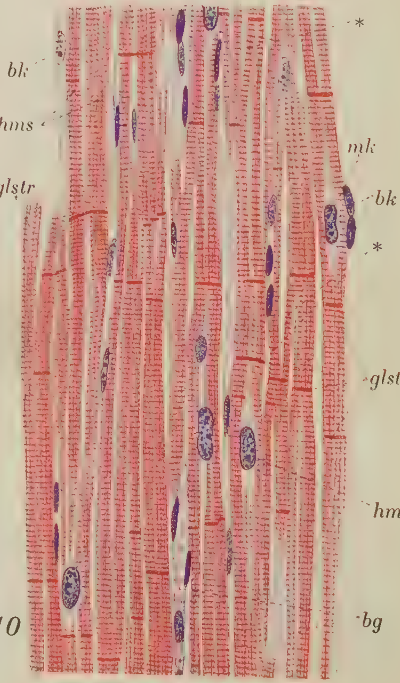
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Fig. 10

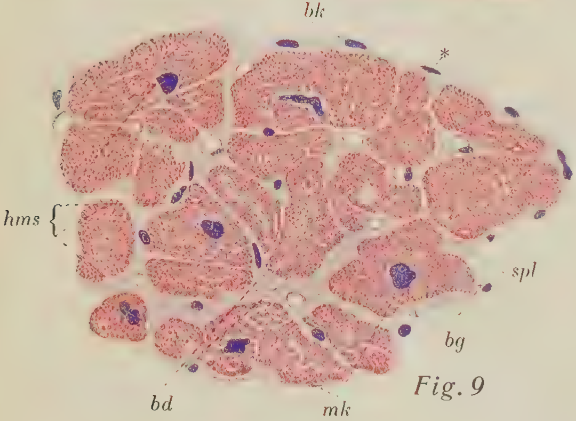
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Fig. 9

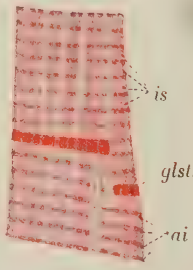

Fig. 11

Plate 12. **Muscular Tissue I.**

Fig. 1. **Fibers of Smooth Muscle** Isolated from the Intestine (Frog). × **250.**

The typical spindle-like form of the fibers of smooth muscle. The elements are cells of but one nucleus. **Technique:** Isolation in 35% caustic potash. Borax carmine.

Fig. 2. **Smooth Muscle** from the Bladder (Frog). × **300.**

Some of the smooth muscle fibers form bundles, others remain single but are so placed as to form a muscular network. Between them is connective tissue. The elongated nuclei of the muscle are easily distinguished from the broader, shorter, and also flatter, nuclei of the connective tissue. **Technique:** The bladder was filled with 2% potassium bichromate solution, then thoroughly washed and the epithelium brushed away. Haematoxylin-eosin.

Fig. 3. **Smooth Muscle** from the Wall of the Uterus (Mouse). × **775.**

The figure represents a part of a transverse section of a horn of the uterus. The external longitudinal layer of muscle is cut across and a part of the adjacent circular muscle has its elements cut longitudinally. The smooth muscle cells here contain small numbers of coarse, strongly stained fibrils which stand out clearly as red lines or points as the case may be. The boundaries of the individual cells (fibers) are not very easy to recognize. Between the two layers of muscle is connective tissue containing many cells. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 4. Part of a **Longitudinal Section of a Thin Fiber of Striated Muscle with Scanty Sarcoplasm** (Human, aet. 28. Execution). × **700.**

The typical picture of a striated muscle fiber. The alternation of dark stained (anisotropic) and paler (isotropic) transverse bands is distinct. In the middle of the former is the isotropic median disc and in the isotropic band there lies the anisotropic intermediate line. Externally is the sarcolemma and immediately beneath it lie the nuclei: the only nucleus cut in the section lies on the right, the others lie in a deeper plane. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 5. Part of a **Longitudinal Section of a Thin Fiber of Human Striated Muscle with Abundant Sarcoplasm.** × **700.**

Since the individual muscle columns are separated by a relatively large amount of sarcoplasm the longitudinal striation of the fiber appears almost more distinct than the transverse. The nuclei are surrounded by much sarcoplasm and are broader and more irregular than in the fiber of *Fig. 4*. **Technique** and source as for *Fig. 4*.

Fig. 6. **Myofibrils** Isolated from a Striated Fiber (Salamander Larva).

The fiber has almost completely fallen apart into its individual fibrils each of which in turn consists of alternating isotropic and anisotropic substances. Note the extreme slenderness of the separate fibrils. **Technique:** 2% Chromic acid. Mechanical isolation. Haematoxylin-eosin.

Fig. 7. **Transverse Section** of a Slender **Fiber of Human Striated Muscle** from the Arch of the Palate. × **1200.**

Because of the abundance of sarcoplasm in the fiber the individual fibrils stand out clearly as also do the so-called Cohnheim's areas resulting from their arrangement into muscle columns. Note the slenderness of the fibrils. As usual the nuclei lie in sacroplasm beneath the sarcolemma. **Technique** as for *Fig. 4*.

Fig. 8. **Branched Fiber of Striated Muscle** from the Human Tongue. × **290.**

Only in the tongue are striated muscle fibers found to branch and then only near their insertion. **Technique** etc. as for *Fig. 4*.

Fig. 9. **Transverse Section of Cardiac Muscle** (Papillary Muscle). × **400.**

The majority of the large regular cross sections belong to fibers of the atrio-ventricular bundle. Note the large irregular nuclei located in a wide central strand of cytoplasm. The abundance of sarcoplasm in the fiber makes clearly distinguishable the individual muscle columns which are often radial. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 10. Part of a **Longitudinal Section of Human Cardiac Muscle.** × **375.**

Fiberlike elements rich in sarcoplasm and with the longitudinal striation often showing more clearly than the transverse. The nuclei lie uniformly in the centers of the fibers and only one nucleus occurs within each central strand of sarcoplasm. The individual fibers are seen to anastomose (*) by branches given off at acute angles. The intercalated discs are visible (Pl. 13, *Fig. 10*). **Technique** etc. as for Fig. *9*.

Fig. 11. An **Intercalated Disc of the Cardiac Muscular Syncytium** and the Parts Adjacent. × **1200.**

From the same preparation as *Fig. 10*. The fibrillar structure of the fiber is evident and the alternation of isotropic and anisotropic substances in each fibril. The intercalated disc is very noticeably dark and is traversed by the somewhat modified fibrils.

ai = anisotropic substance
bd = connective tissue
bk, bdk = connective-tissue nuclei
bg = blood vessels
bz = connective-tissue cells
fi = fibrils
fi_1 = fibrils cut lengthwise
fi_2 = fibrils cut across

glstr = intercalated discs
hms = cardiac muscular syncytium
is = isotropic substance
lm = longitudinal muscle
mk = nuclei of muscle fibers
mk_2 = nuclei in a deeper plane of the preparation

ms = muscle columns
msch = median discs
sl = sarcolemma
spl = sarcoplasm
zsch = intermediate line
* = anastomoses of cardiac muscle fibers

Plate 13. **Muscular Tissue II.**

Ths mul

Fig. 1. **Smooth Muscle from the Intestine (Cat). Cut Transversely.** × **600.**

The cross sections of the muscle cells appear as irregularly rounded areas the size of which varies with the part of the fusiform muscle fiber included in the section. For the same reason only a few of the cross sections show nuclei. Some of the fibers appear homogeneous, in others cross sections of the fibrils are seen as points. Between the fibers lie the delicate connective-tissue membranellae. **Technique:** Müller's fluid. Paraffine. Delafield's haematoxylin.

Fig. 2. **Smooth Muscle from the Intestine (Cat). Cut Longitudinally.** × **600.**

The muscle cells appear striated longitudinally (fibrillae). The membranellae between them are shrunken and simulate intercellular bridges (artefact). **Technique:** Absolute alcohol. Paraffine. Haematoxylin.

Fig. 3. Part of a **Longitudinal Section** of a **Striated Muscle Fiber** Rich in Sarcoplasm **(Tongue of Dog).** × **1150.**

Both longitudinal and transverse striations are clearly seen. Abundant hypolemmal sarcoplasm separates the sarcolemma from the striated material, and within it lie two nuclei. Anistropic substance dark, isotropic substance pale. Both the isotropic median disc and the anisotropic intermediate line are to be seen. **Technique:** Sublimate. Paraffine. Iron haematoxylin.

Figs. 4—6. **Transverse Sections through Muscle Fibers Rich in Sarcoplasm (Human Tongue. Execution).** × **1150.**

The three fibers differ greatly in size; that of *Fig. 6* is cut quite near its termination in a tendon and its nucleus lies in a large mass of sarcoplasm. In *Fig. 4* are three typical hypolemmal nuclei closely applied to the inner surface of the sarcolemma. The distribution of the fibrillae differs greatly in the three figures; in the thick fiber (*Fig. 4*) it is almost uniform; in *Fig. 5* there is a distinct grouping into fields which however are irregular; one such is indicated in *Fig. 6*. Note that the fibrils near the end of a fiber (*Fig. 6*) are much finer than in the middle of its length (*Fig. 4*). **Technique:** Zenker's fluid. Paraffine. Iron haematoxylin—orange.

Fig. 7. **Ends of Three Isolated Fibers of Striated Muscle** (Frog). × **100.**

Of the ends of the three muscle fibers, that at the left terminated intermuscularly, the other two in tendons. Striation indistinct, nuclei evident, increased numbers of nuclei at the ends of the fibers. **Technique:** Isolation in caustic potash.

Fig. 8. **Fiber of Striated Muscle** Cut Longitudinally and **Terminating in a Tendon (Human Tongue.** Execution). × **1200.**

The transverse striation is quite similar to that of *Fig. 3*. The longitudinal striation which allows the individual fibrils to be seen is almost equally distinct. The picture of the transverse striation is destroyed toward the upper narrowed end of the fiber near the tendon by displacement of the fibrillae. Toward the same end the fibrils become noticeably thinner (cf. *Figs. 4 and 6*) and lose their striation. Even in this part of the fiber a nucleus is seen at the boundary of the sarcolemma. The fibrillae, no longer segmented, are continued on through the sarcolemma into the fibrils of the tendon. **Technique** as for *Figs. 4—6*.

Fig. 9. **Two Fibers of Striated Muscle Exceedingly Rich in Sarcoplasm Terminating in a Tendon** (Dorsal Fin of a **Sea-horse**). × **750.**

The continuity of the muscle and tendon fibrils is obvious. The myofibrils lose their striation some distance from the tendon; they are very clearly seen to pass through the sarcolemma and continue directly into the fibrils of the tendon. Note the structure of the sarcoplasm. **Technique:** O. Schultze's osmium-haematoxylin method.

Fig. 10. **Longitudinal Section of Cardiac Muscle.** General View. × **350.**

The nuclei lie centrally in clear areas of sarcoplasm. Lateral branchings occur and anastomoses. Intercalated discs. The very delicate sarcolemma is not to be seen in this enlargement. A small amount of connective tissue lies between the fiberlike elements. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

ai = anisotropic substance
bd = strand of connective tissue
fi = fibrils
fim = myofibrils
ftt = fibrils of tendon
gl = intercalated discs
glm = smooth muscle fibers
glm_1 = cross sections of smooth muscle fibers apparently homogeneous
glm_2 = cross sections with nuclei
glm_3 = fibrillated cross sections
is = isotropic substance
k = nuclei of muscle fibers
m = muscle fibers
me = membranellae of smooth muscle
mel = elements of cardiac muscle
msch = median disc
sb = end of sarcolemmal tube
sl = sarcolemma
spl = sarcoplasm
spl_1 = hypolemmal sarcoplasm
te = tendon
tk = nuclei in tendon
zsch = intermediate line
* = invaginations of the sarcolemmal tube where the fibrils pass through it

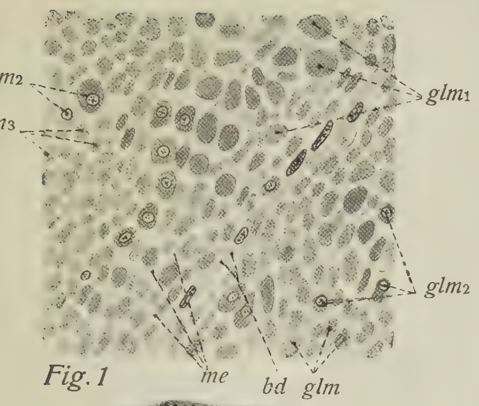
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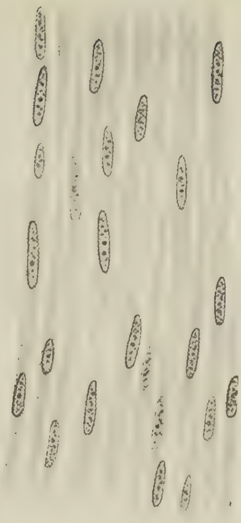
Fig. 1



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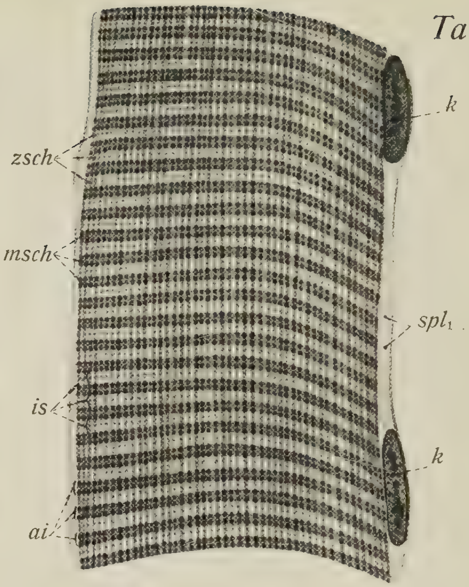
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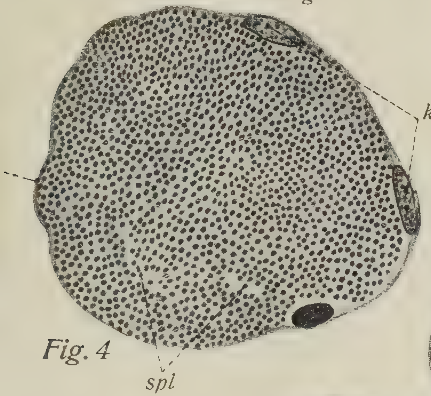

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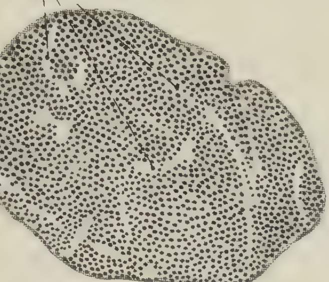


Fig. 5

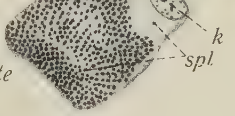


Fig. 6

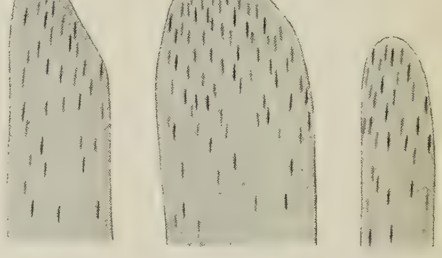
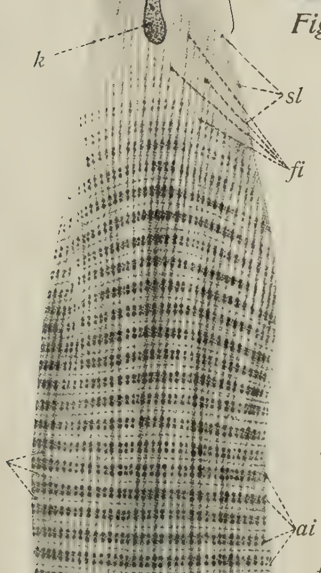


Fig. 7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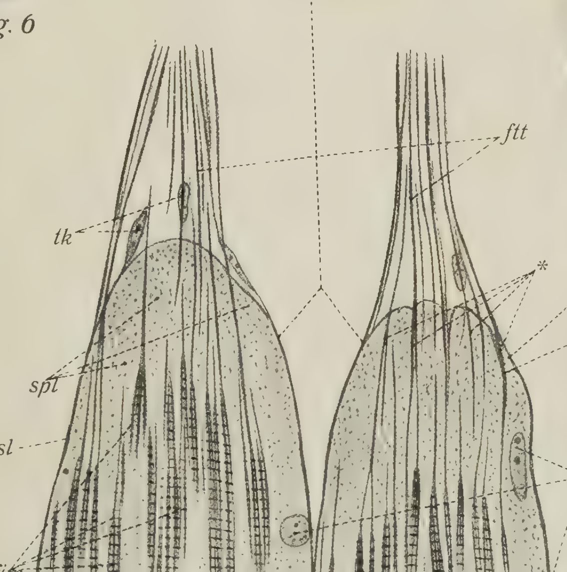
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Fig. 9

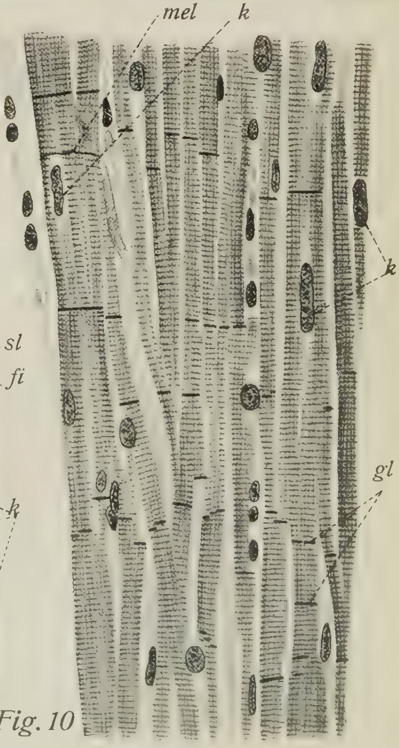


Fig. 10

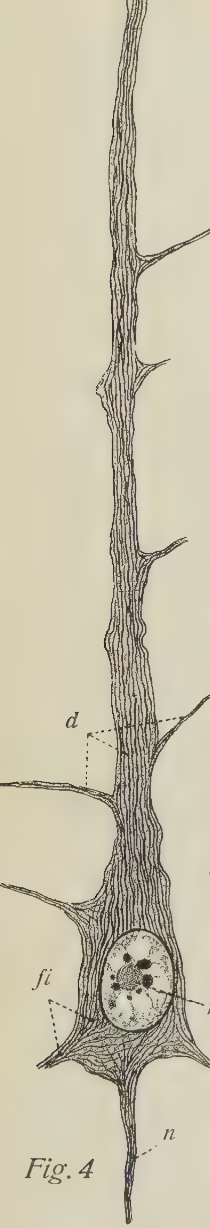


Fig. 4

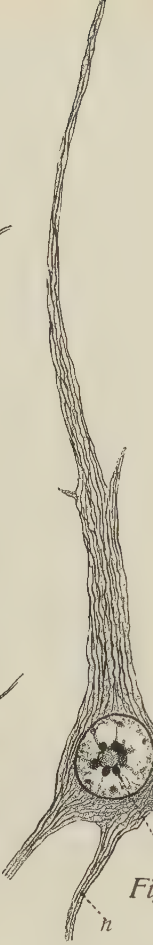
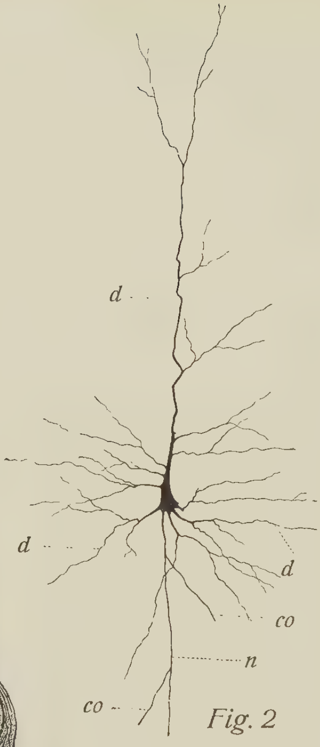


Fig. 3



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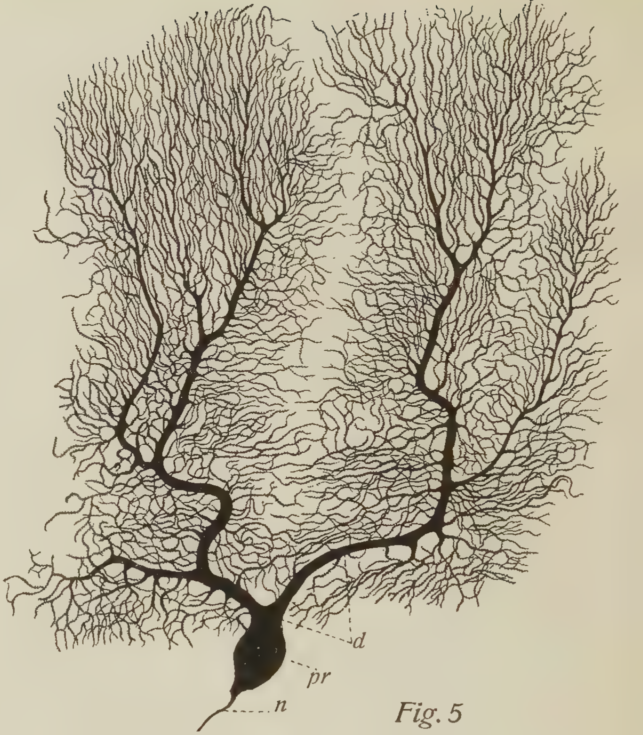

Fig. 5

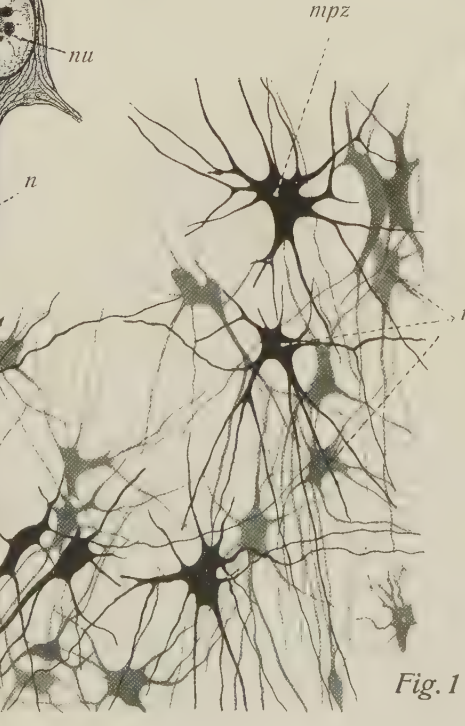

Fig. 1

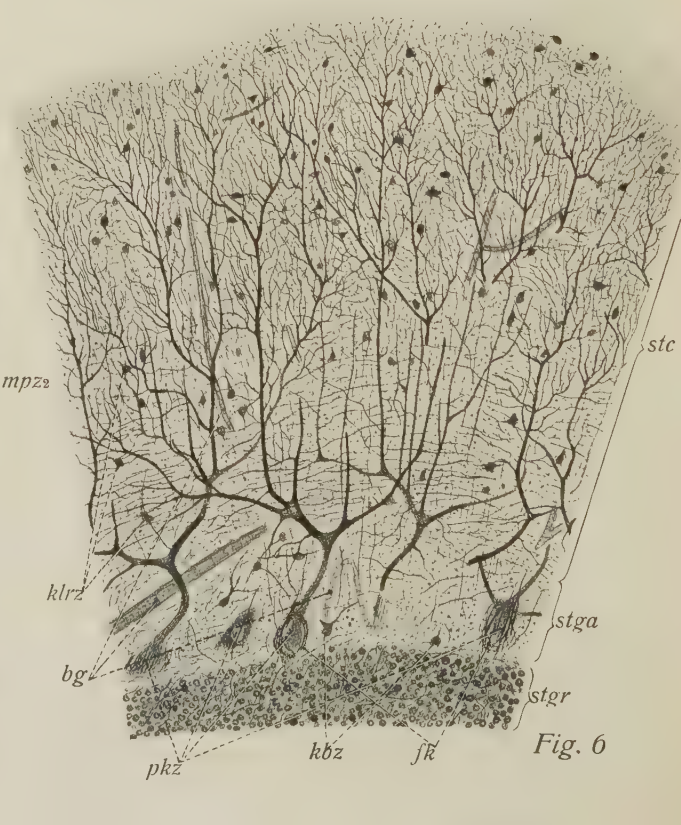
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Fig. 6

Plate 14. **Nervous Tissue I.**

Fig. 1. **Multipolar Nerve Cells** from the Anterior Cornu of the Spinal Cord (Cat). × **125.** There are seen a number of so-called multipolar cells with their polyhedral cell bodies and their dendrites. They appear quite black from the silver impregnation. The territories of the individual cells with their branching dendrites overlap. The cells lying in the deeper planes are shown in grey. **Technique:** Potassium bichromate—osmic acid. Golgi's silver impregnation.

Fig. 2. **Pyramidal Cell from the Human Cerebral Cortex.** × **90.** There is seen the cell body of pyramidal form and the dendrites extending in three principal directions. The axone springs from the base of the cell and gives off two collaterals. **Technique** etc. as for *Fig. 1.*

Figs. 3 and 4. **Two Pyramidal Cells from the Cerebral Cortex** (Cat). **Neurofibrils.** × **800.** Only the cell body proper and the proximal parts of the processes are represented. The typical resting nucleus of the cell and the interlacement of neurofibrils in the protoplasm stand out clearly; the courses of the fibrils are essentially parallel and they pass on into the dendrites as well as into the axone. There is no real network of the fibrils. **Technique:** Neurofibril method of Ramon y Cajal.

Fig. 5. **Cell of Purkinje** from the Human Cerebellar Cortex. × **190.** An example of a large nerve cell provided with an elaborate dendritic arborization. The branches of the dendrite all lie in the same plane. The axone proceeds from the point of the pear-shaped cell body; from its opposite end there arise close together two main dendrites which arborize to an extraordinary degree. On the finest branches are delicate bristle-like projections — artefacts. The whole cell appears perfectly black from the impregnation. **Technique** as for *Fig. 1.*

Fig. 6. **Neuropil** of the Stratum Cinereum of the Human Cerebellar Cortex. × **140.** There is seen the entire stratum cinereum and stratum gangliosum of the cerebellum as well as the adjacent part of the stratum granulosum. The stratum cinereum is essentially a neuropil, *i. e.* it is filled with the crossing and interweaving processes of the dendrites of the large Purkinje cells to which are added the axones and telodendria of the granular cells which run parallel to the surface and are visible as points between the entangled dendrites. This layer shelters but few cells, the so-called small cortical cells; and its superficial zone contains no neuropil but is pure neuroglia. **Technique:** Formol. O. Schultze's caustic soda—silver method.

bg = blood vessels
co = collaterals
d = dendrites
fi = fibrils
fk = fiber baskets about the Purkinje cells
k = nucleus
kbz = basket cells
klrz = small cortical cells
mpz = multipolar cells in the plane of the section
mpz_2 = multipolar cells in a deeper plane
n = axone
nu = nucleolus
pr = protoplasm
pkz = Purkinje cells
stc = stratum cinereum
stga = stratum gangliosum
stgr = stratum granulosum

Plate 15. **Nervous Tissue II.**

Figs. 1—3. **Unipolar Nerve Cells** from the Spinal Ganglia. × **650.** There is to be recognized the more or less spherical form of the cell body with the nucleus lying at its center and the axone passing away. Neurofibrils are distinct in spite of the intense staining of the cell; and in the spherical resting nucleus is a distinct nucleolus. Around the dark-staining cell-body lies a pale tissue containing numerous nuclei. The larger nuclei lying near the surface of the cell are probably nuclei of Schwann's amphicytes, the smaller are connective-tissue nuclei. In *Fig. 1* the axone is to be seen passing away from the cell which lacks dendrites; an axone (from another cell?) encircles the cell represented. In *Fig. 2* is seen an axone strikingly stout in proportion to the size of the cell, also the neurofibrils show clearly as they leave the cell body and pass into the axone. *Fig. 3* shows not only the axone leaving the cell but also its T-shaped division close to the cell. **Technique:** The O. Schultze-Gross method.

Fig. 4. **Bipolar Nerve Cells** from the Spiral Ganglion (Cat). × **800.** More or less markedly elliptical cells surrounded by nucleated capsules. Nerve fibers are medullated close up to the cell. The connection of the nerve fiber with the cell is especially clear at nz_1; from each of the opposite poles of the elliptical cell body there emerges a fiber which is without medulla for only a short distance and then acquires a thin medullary sheath shown dark in the figure. **Technique:** Platinum chloride—osmo-acetic acid. Reduction by pyroligneous acid. Celloidin.

Fig. 5. **Multipolar Nerve Cells from the Human Sympathetic Nervous System** (Execution). × **225.** General view of a section of the superior cervical ganglion. Both nerve cells and nerve fibers are clearly shown. Long slender processes (dendrites) with but few branches proceed from relatively small cells with almost spherical cell bodies (cf. Pl. 16, *Fig. 6*). The cells, since they belong to the peripheral nervous system, are situated within the nucleated sheath of Schwann and the connective-tissue sheath. From several cells, particularly from a large one near the middle of the figure, axones run to join groups of nerve fibers; indeed as a rule several axones arise from one cell. **Technique** and source as for *Figs. 1—3.*

Fig. 6. Two **Cells of the Sympathetic Nervous System.** × **500.** The two cells are taken from a rather insufficiently differentiated section so that the strikingly eccentric nuclei are quite dark. The cells are of somewhat different types. In addition to the axone running toward the right, one cell sends out other similar processes, doubtless also axones. The other cell shows relatively short slender processes (dendrites?) proceeding directly from the cell body, they soon divide. Several axones (2—5) are also visible with certainty. An extensive arborization of dendrites such as that of the multipolar cells of the cerebrospinal system does not occur here. Near the surface of the cell body are the pale nuclei of Schwann's amphicytes. **Technique** and source as for *Figs. 1—3.*

bh = connective-tissue capsule
bk = nuclei of connective-tissue or Schwann's nuclei as the case may be
k = nuclei of amphycytes
kn = nuclei of nerve cells
neu = axone
neu_1 = axone dividing
nu = nucleoli
nf = nerve fibers
nz = nerve cells
nz_1 = nerve cell with two axones
pr = protoplasm
* = origin of axone

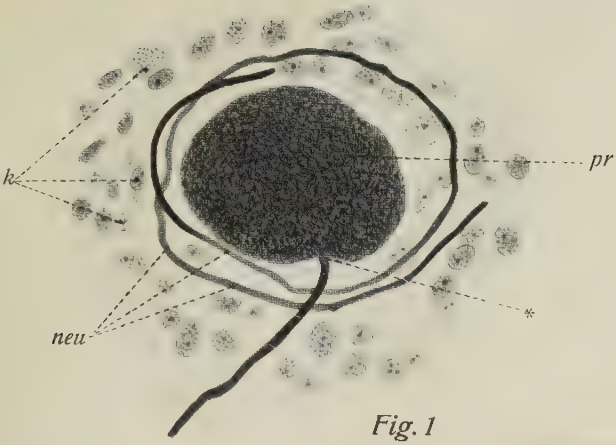

Fig. 1

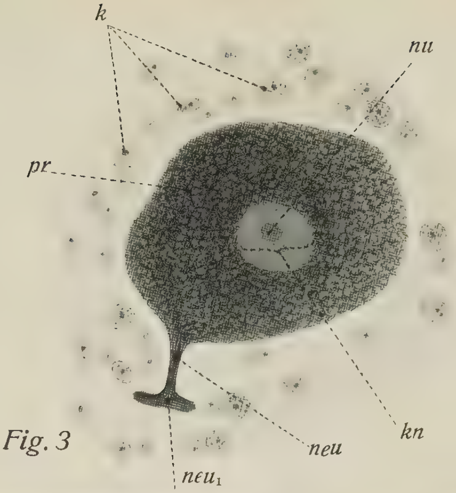
k
nu
pr
kn
neu
neu_1

Fig. 3

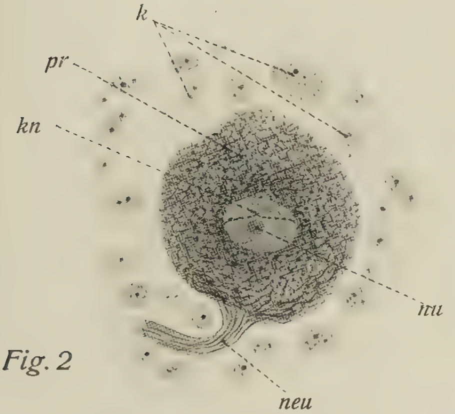
k
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Fig. 2

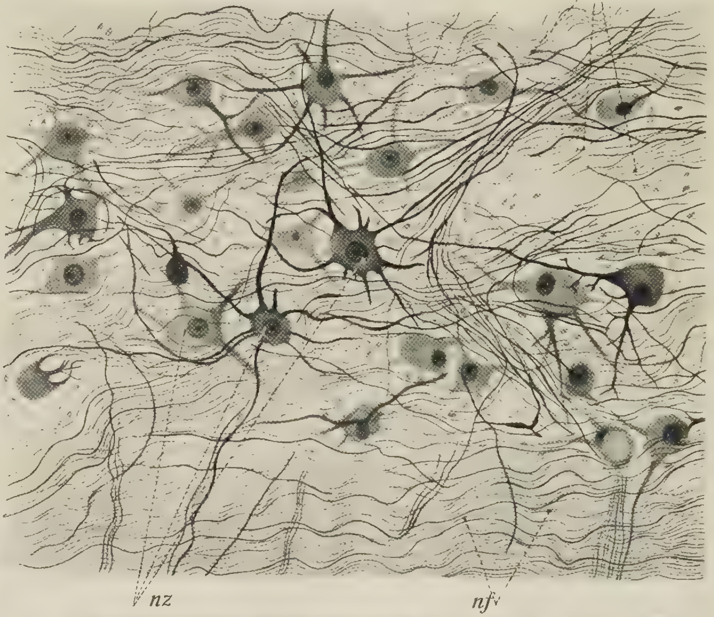
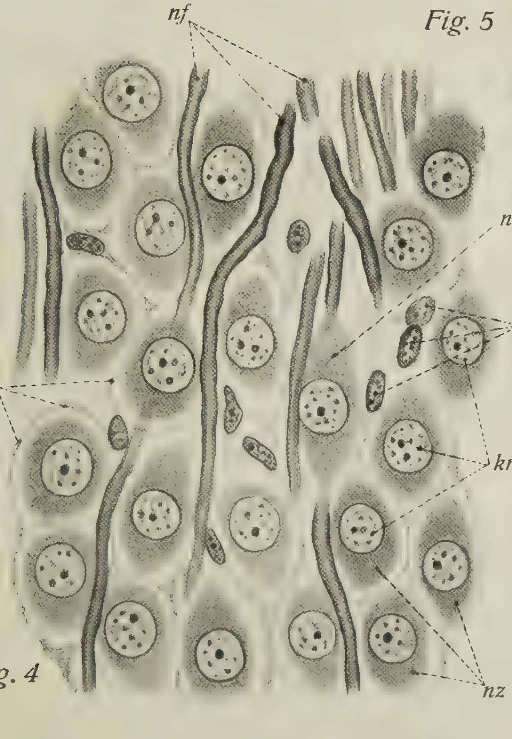


Fig. 5


nf
nz_1
bk
kn
nz

g. 4

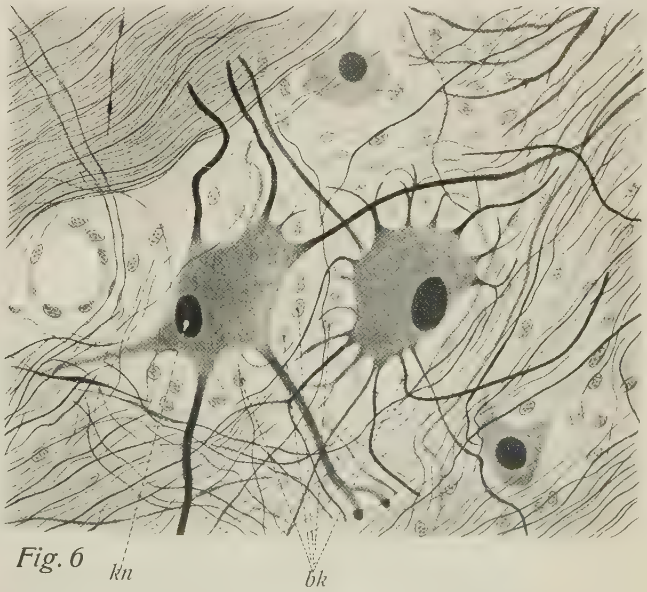


Fig. 6

Tab. 16

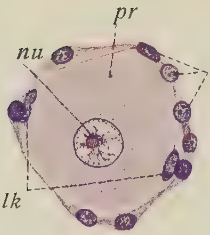


Fig. 2

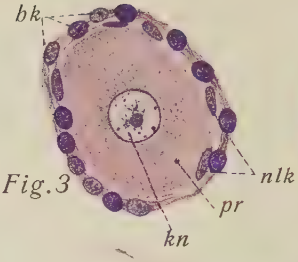


Fig. 3

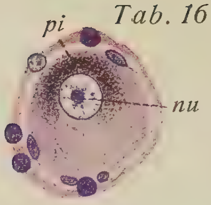


Fig. 4

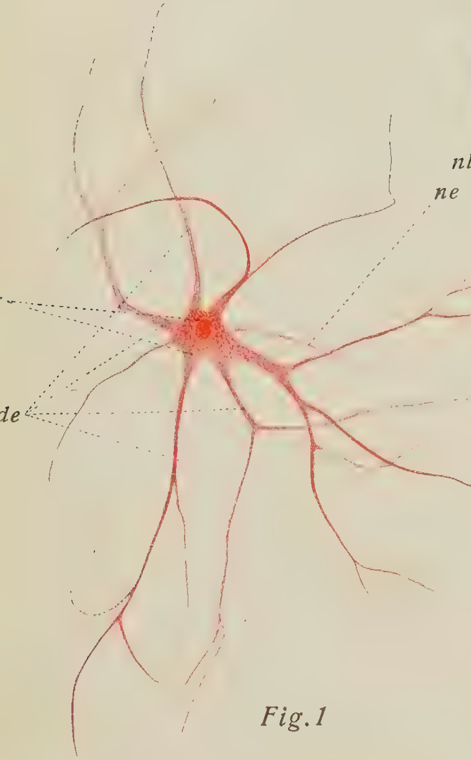


Fig. 1

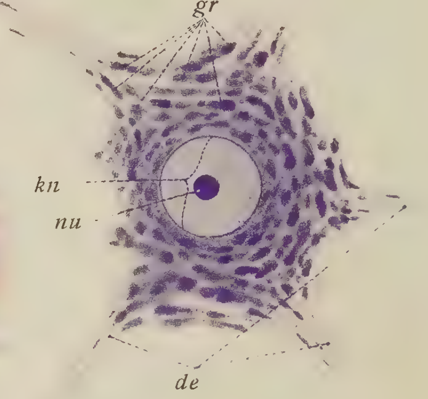


Fig. 6

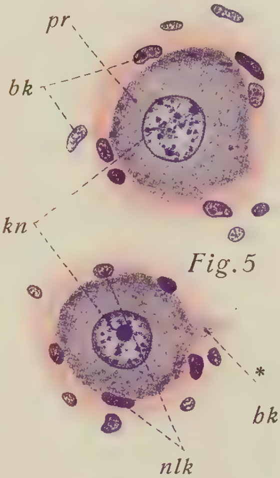


Fig. 5

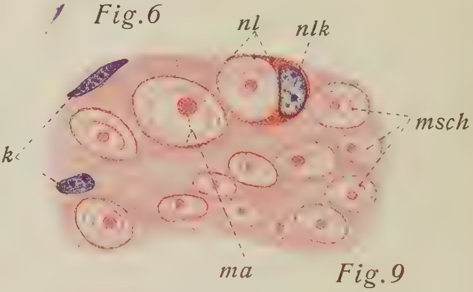

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Fig. 9

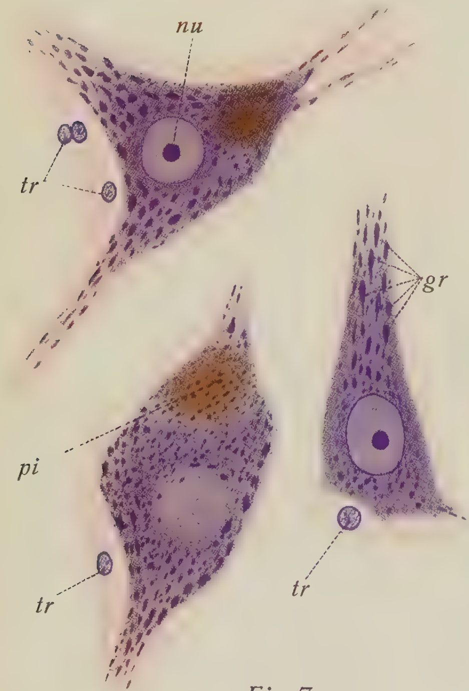
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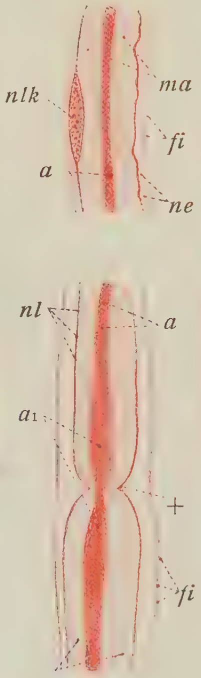
Fig. 7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nl
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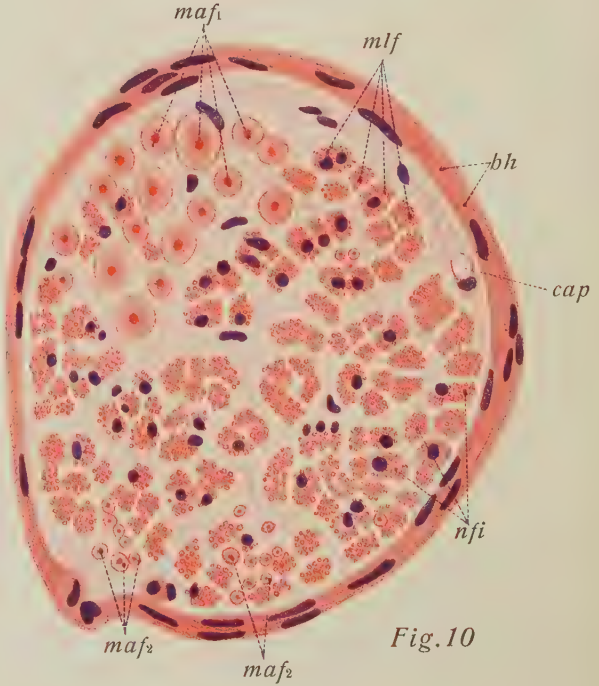
a_1
+
fi
ma

Fig. 8


maf_1
mlf
bh
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nfi
maf_2
maf_2

Fig. 10

Plate 16. **Nervous Tissue III (Nerve Cells and Nerve Fibers).**

Fig. 1. **Multipolar Nerve Cell** Isolated from the Anterior Cornu of the Human Spinal Cord. × **180.**

The preparation shows the large cell body with many branching dendrites, some of the twigs of which were too fine to be pictured while others were torn off. The axone is unbranched. The nucleus appears quite homogeneous; the protoplasm contains indistinct granulations. **Technique:** Maceration of the grey matter in chromic acid 1:10000. Neutral carmine. Coverglass, dry preparation.

Figs. 2—4. **Ganglion Cells** from a Section through a **Spinal Ganglion** (Human, aet. 22. Execution). × **450.**

The bodies of the cells are large with spherical nuclei. The flattened nuclei of Schwann are applied to the surface of the cell and outside of them in turn lies the nucleated connective-tissue capsule. The process (axone) is not made visible by this technique. *Fig. 6* shows a somewhat smaller cell distinctly pigmented by yellowish brown lipofuscin. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 5. Two **Sympathetic Nerve Cells** of a Small Ganglion from the Peritoneal Cavity (Human. Execution). × **600.**

By the usual methods of staining there is to be seen in these cells only the approximately spherical cell body with relatively large nucleus and also the nuclei of the neurolemmal and connective-tissue sheaths. Marked indications of the cell process are recognizable (cf. Pl. 15, *Fig. 6*). **Technique** as for *Figs. 2—4.*

Fig. 6. **Nerve Cell** from the Anterior Cornu of the Spinal Cord (Child). × **850.**

The preparation shows the violet stained Nissl bodies (tigroid bodies, cytochromatin). **Technique:** Absolute alcohol. Paraffine, Kresylviolet-eosin.

Fig. 7. Three **Nerve Cells with Satellite Cells** from the Human **Cerebral Cortex.** × **850.**

The section represented contains the main part of the cell body and the proximal parts of the processes. The chromatophilic granules are distinct. In one of the cells is a dense accumulation of lipofuscin pigment. Of the satellite cells little is to be seen except the nucleus. **Technique** as for *Fig. 6.* Toluidinblue—eosin.

Fig. 8. Two Sections of a **Medullated Nerve Fiber** (Rabbit). × **500.**

Below there is represented a node of Ranvier, above a part of a fiber showing at the left a neurolemmal nucleus lying upon it. The axis cylinder is greatly shrunken and stained red; in the neighbourhood of the node it shows biconical expansions. Surrounding it is the greatly swollen medullary sheath showing a delicate framework and lying close to the sheath is the neurolemma with (upper figure) a rather thick elongated nucleus. Externally at a certain distance, which has been increased artificially by isolation, is seen the fibrillar (endoneural) sheath of Henle, here almost structureless. **Technique:** Müller's fluid. Carminic acid, in toto. Sodium carbonate. Teased preparation.

Fig. 9. Part of a Transverse Section of a Small **Medullated Nerve** from a Human Skeletal Muscle. × **1000.**

Within the endoneurium lie a number of medullated fibers of very different diameters. One of the thicker fibers shows a nucleus in its neurolemma. Note how the nucleus is enclosed by the syncytial protoplasm of the neurolemma. Here also the medullary sheaths are greatly swollen and the axis cylinders shrunken; the former show a concentric structure. **Technique** as for *Fig. 2.*

Fig. 10. Transverse Section of a Slender **Nerve** from the **Sympathetic** Nervous System (Human Pelvis Minor). × **600.**

This small branch of a nerve is surrounded by a compact wrapping of connective tissue; non-medullated nerve fibers greatly predominate. Note their relatively large size, the irregular form, the numerous neurolemmal nuclei and above all the exceedingly distinct fibrils. Beside the non-medullated fibers there are singly, or in groups, medullated fibers of very different diameters, the medulla of which shows a radial structure in this figure. (Here again the medullary sheaths are swollen and the axis cylinders shrunken.) **Technique** as for *Fig. 8.*

a = axis cylinder
a_1 = biconic expansion of axis cylinder
bh = connective-tissue capsule of sympathetic ganglion
bk = nuclei of connective-tissue capsule
cap = blood capillaries
de = dendrites
end = endoneurium
fi = fibrillar sheath
gr = tigroid granules
kn = nuclei
ma = medullary sheath
maf_1 = large medullated nerve fibers
maf_2 = slender medullated nerve fibers
mlf = non-medullated nerve fibers in cross section
msch = medullary sheath
ne = axone
nfi = neurofibrils
nl = neurolemma
nlk = nucleus of neurolemma
nu = nucleoli
pi = pigment
pr = protoplasm
tr = satellite cells
+ = node of Ranvier
* = origin of process from body of cell

Plate 17. **Nervous Tissue IV (Nerve Fibers).**

Fig. 1. **Medullated Nerve Fiber** (Frog). × **900.** Fresh in physiological salt solution. Optical longitudinal section. In the interior is the thick, pale axis cylinder which appears absolutely structureless. Surrounding it is the relatively thin, highly refractive, double contoured medullary sheath which is interrupted at the node of Ranvier and also contains some indistinct oblique incisures. The neurolemma is visible chiefly at the node as a thin, delicate membrane.

Fig. 2. **Medullated Nerve Fiber,** Boiled in Alcohol. **Framework of Neurokeratin** (Frog). × **700.** Axis cylinder greatly shrunken. The lipoid medullary substance is dissolved; a non-lipoid network (artefact ?) is left in the region of the medullary sheath (Neurokeratin).

Fig. 3. Part of a **Medullated Nerve Fiber** (Rabbit) Treated with Silver Solution. × **375.** The axis cylinder and the cement at the node are blackened by the action of the silver while the medullary sheath remains unstained. Near the node the axis cylinder shows a transverse striation, an artefact. **Technique:** Treatment with 1% silver nitrate solution. Reduction of the silver by sunlight.

Fig. 4. Three **Medullated Nerve Fibers** from the Mesentery (Cat). × **500.** The medulla is blackened by the action of osmic acid and shows clearly the Schmidt-Lanterman incisures. On one fiber a neurolemmal nucleus lies. (The medulla is not swollen.) **Technique:** Platinum chloride—osmo-acetic acid. Treatment with methyl alcohol and red pyroligneous acid.

Fig. 5. Two Human **Medullated Nerve Fibers** Running in Connective Tissue. × **500.** The fiber on the right is very slender and shows a very thin medullary sheath. On the left the medullary sheath has broken up into segments at the Schmidt-Lanterman incisures. **Technique:** Solution of osmic acid.

Fig. 6. Human **Medullated Nerve Fibers with Medullary Sheaths Stained;** Longitudinal Section. × **600.** Stove-pipe and fish-bone structure of the medulla. **Technique:** Spielmeier's method of staining (with haematoxylin) medullary sheaths in frozen sections.

Fig. 7. **Transverse Section of Medullated Nerve Fibers** (Frog). × **600.** The medulla has been blackened by osmic acid, it is but little swollen and exhibits concentric rings. In the axis cylinders which have scarcely shrunken the cross sections of fibrils are to be seen. **Technique** as for *Fig. 5.*

Fig. 8. Section through a Small Sympathetic Nerve Consisting Entirely of **Non-medullated Fibers.** From the Peritoneal Cavity (Human, aet. 21. Execution). × **700.** The nerve changes direction and is cut crosswise in the upper and lengthwise in the lower parts of the figure. The nerve is formed of small bundles separated by connective tissue; within each bundle is seen a small number of non-medullated fibers. In the cross sections of the fibers the fibrils composing the axis cylinders are visible (cf. Pl. 16, *Fig. 10*). In the part of the nerve cut longitudinally the nuclei appear greatly elongated. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

ax = axis cylinders
ax_1 = axis cylinder at a node
ax_2 = axis cylinder striated transversely
bdk = nuclei of connective tissue
mlf_1 = medullated fibers in longitudinal section
mlf_2 = longitudinal changing into transverse sections
mlq = non-medullated nerve fibers cut across
mnf_1 = slender medullated fiber
msch = medullary sheath
neur = neurolemma
nk = nuclei of neurolemma
+ = node of Ranvier
* = stove pipe formation
** = fishbone formation

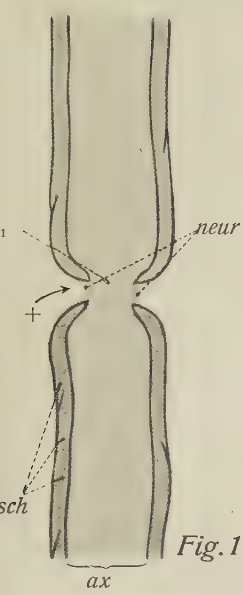


Fig. 1

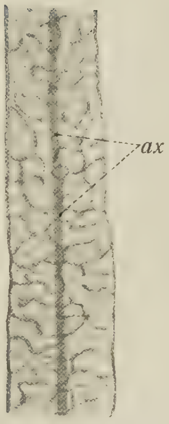


Fig. 2

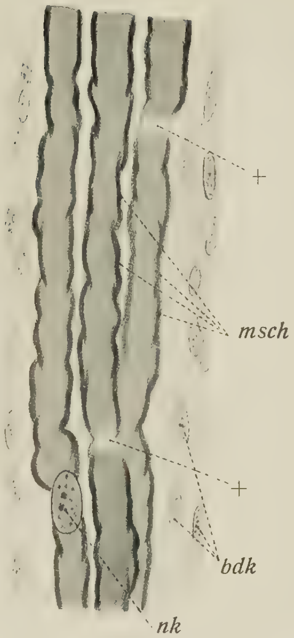


Fig. 4

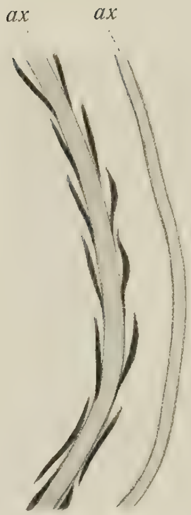


Fig. 5

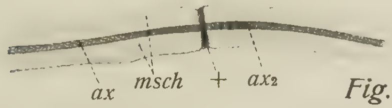


Fig. 3

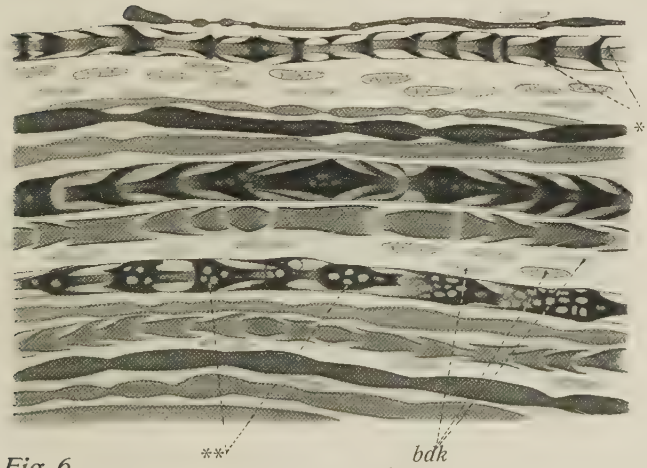
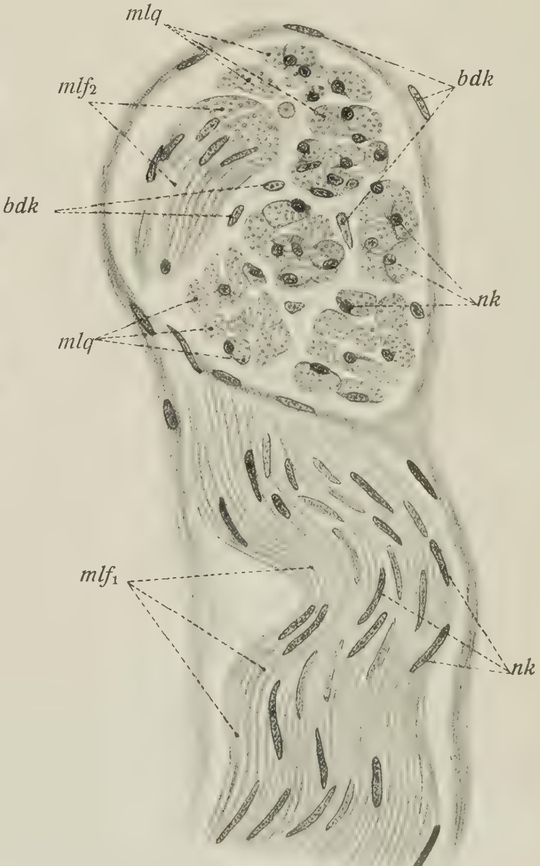


Fig. 6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mlq
mlf₁
nk

Fig. 8

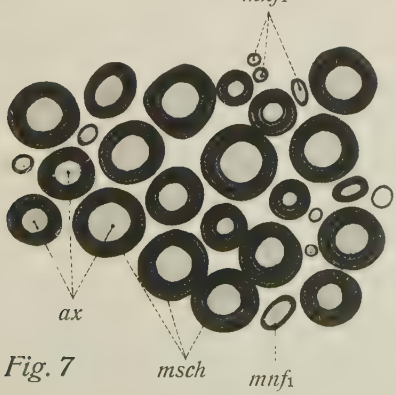

mnf₁
ax
msch
mnf₁

Fig. 7

Tab. 18

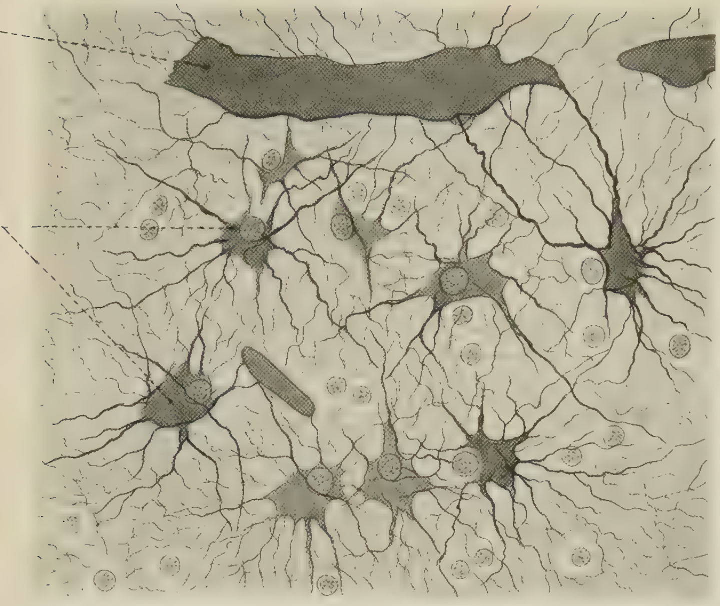


Fig. 5

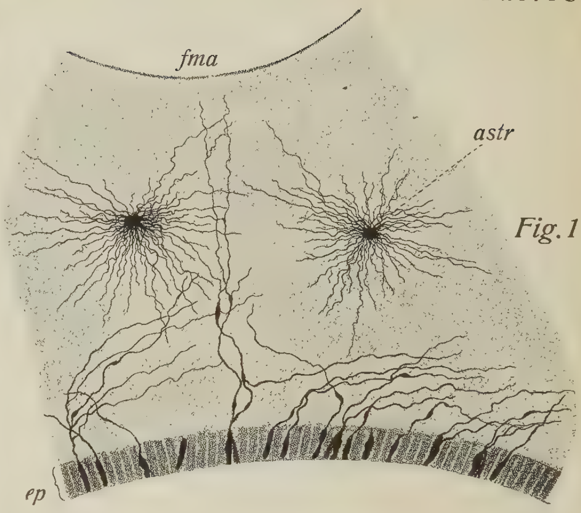
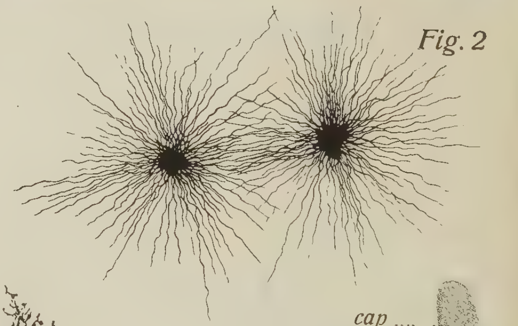


Fig. 1



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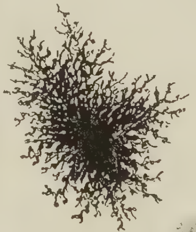

Fig. 3

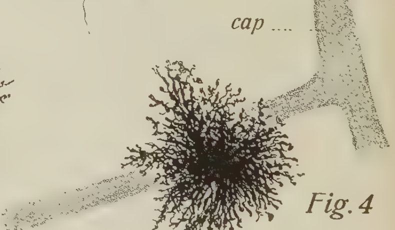

Fig. 4

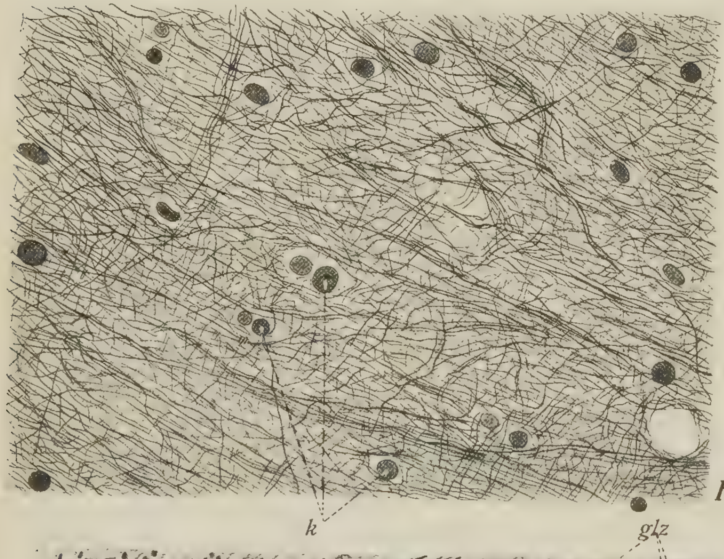

Fig. 6

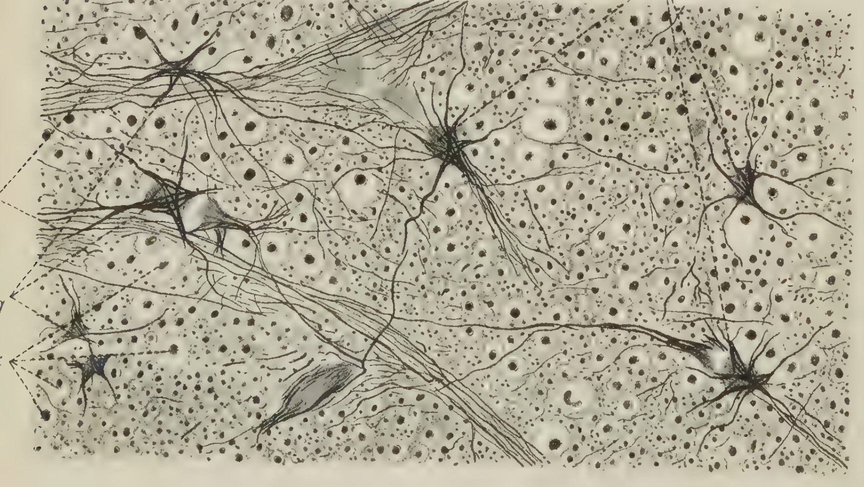

Fig. 7

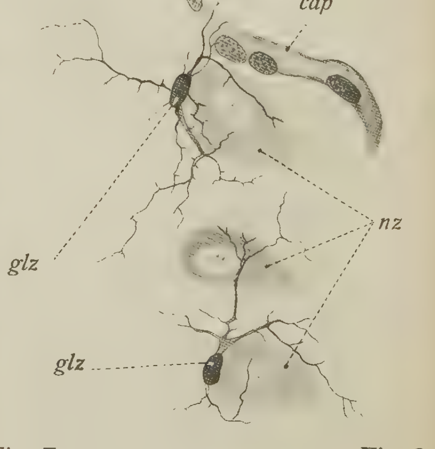
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Fig. 8

Plate 18. **Nervous Tissue V (Neuroglia).**

Fig. 1. **Ependymal Glia.** Part of a Section of Spinal Cord (New born Child). × **120.** There is seen the region between a part of the ependymal lining of the central canal (below) and the bottom of the anterior median fissure (above). A number of ependymal cells with their extensions and also two astrocytes (long-rayed) are demonstrated (impregnated) by the method of **technique** used, viz. Golgi's silver impregnation. The other ependymal cells look like ordinary columnar epithelial cells. Ependymal glia fibers.

Fig. 2. **Neuroglia.** Two Long-rayed **Astrocytes** from the White Matter of the Medulla Oblongata (Child). × **110.** By this method the glia fibers as a whole appear to be extensions of the cells. **Technique** as for *Fig. 1.*

Figs. 3 and 4. **Neuroglia.** Two Short-rayed **Astrocytes** from the Grey Matter of the Human Cerebral Cortex. × **250.** One cell is applied to a capillary. The method appears to show that the cells have short but greatly branched processes. **Technique** as for *Fig. 1.*

Fig. 5. **Neuroglia** from the Hippocampus of the Human Brain. **Cellular Glia.** × **70.** Several glia cells are to be recognized with their nuclei and numerous branches. Within the processes of the cells are a few entirely intracellular fibrous elements; some of these join the wall of a blood vessel. The cellular nature of the tissue is clearly demonstrated by this method, the cells correspond to the short-rayed astrocytes of the Golgi method. **Technique:** Gold-sublimate method of Ramon y Cajal.

Fig. 6. **Glia Fibers** from the Grey Matter of the Human **Spinal Cord.** × **600.** The method shows clearly the fibrous elements of the tissue, otherwise only the nuclei of the glia (*k*) are recognizable. Note the close interlacement of the glia fibers (gliopil). **Technique:** Holzer's method for staining neuroglia.

Fig. 7. **Neuroglia** from the **White Matter** of the Spinal Cord. × **60.** Transverse sections of numerous medullated nerve fibers of different diameters are visible and among them bundles of anterior root fibers cut longitudinally. Glia cells are visible at rather regular intervals. Only the shapes of the bodies of the glia cells can be seen, not the nuclei. It is clearly seen that the fibers run through the bodies of the cells, these are the so-called long-rayed astrocytes (cf. *Fig. 2*). **Technique:** The O. Schultze-Gros silver—caustic soda process.

Fig. 8. **Microglia, Fiberless Glia, Hortega Cells of the Neuroglia.** × **640.** Two Hortega cells with three nerve cells and a capillary. The upper cell is applied to the nerve cell like a satellite cell and also enters into relation with the capillary. Note the slender form of the cell, the small cytosome, the large nucleus and the delicate processes. No glia fibers. **Technique:** Del Rio Hortega's silver carbonate method.

astr = astrocyte
ax = axis cylinder
bg = blood vessel
cap = capillary
ep = ependymal epithelium
fma = anterior median fissure
glz = glia cells
k = nucleus
nfl = nerve fibers cut longitudinally
nfq = nerve fibers cut transversely
nz = nerve cells

Plate 19. **Bone I.**

Fig. 1. Part of a **Transverse Section of a Tubular (Long) Bone** (Shaft of **Human Radius**). × **100.** The figure extends from the periosteal surface nearly to the middle of the compact substance. The Haversian canals are obvious at a glance, being filled with black detritus from the grinding. The lamellae show a concentric arrangement around the lumina of the canals. The lacunae and canaliculi both appear black by transmitted light and are seen related to the interstitial lamellae or to those of the Haversian systems. **Technique:** A plate of bone is ground until thin.

Fig. 2. Part of a **Longitudinal Section of a Human Tubular (Long) Bone.** × **100.** The Haversian canals are cut lengthwise instead of across as in the previous figure. **Technique** as for *Fig. 1.*

Fig. 3. Part of a **Transverse Section of a Decalcified Tubular (Long) Bone** (Human). × **48.** General view of the structure of a bone. The section goes through the entire thickness of the bone (shaft of radius) from the periosteum on the left to the marrow cavity on the right. The Haversian canals being empty appear clear. The systems of lamellae which surround them differ greatly in thickness, comprising as they do from few to many lamellae. Interstitial and ground lamellae are to be seen in addition to the Haversian lamellae and are often to be recognized by a different intensity of stain. The bone cells appear only as points. Note that in general the narrower Haversian canals lie toward the periosteum, the wider toward the marrow cavity into which bars of spongy bone project. **Technique:** Müller's fluid. Decalcification by hydrochloric acid. Haematoxylin-eosin.

Fig. 4. Part of a Section of a Human **Mandible. Volkmann's Canal.** × **200.** The canal, filled by a large blood vessel, penetrates the lamellae which are not concentric around it. **Technique** as for *Fig. 3.*

agl = external ground lamellae
bg = blood vessel
igl = internal ground lamellae
il = interstitial lamellae
hk = Haversian canals
hk_1 = large Haversian canal
hl = Haversian lamellae
kh = lacunae
kh_1 = lacunae cut lengthwise and viewed from the surface
kn = bone
pe = periosteum
sp = substantia spongiosa
vk = Volkmann's canals

Tab. 19

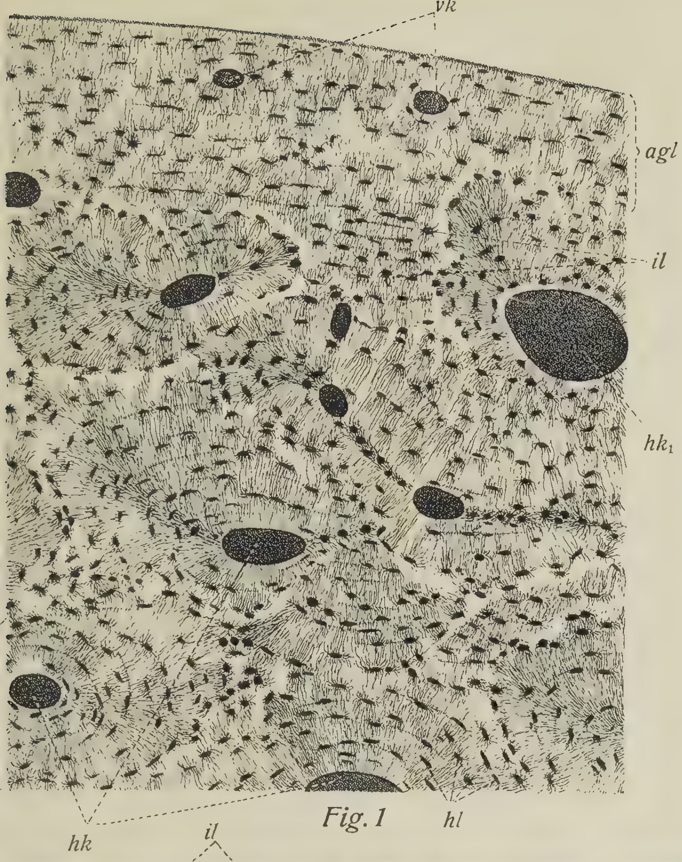
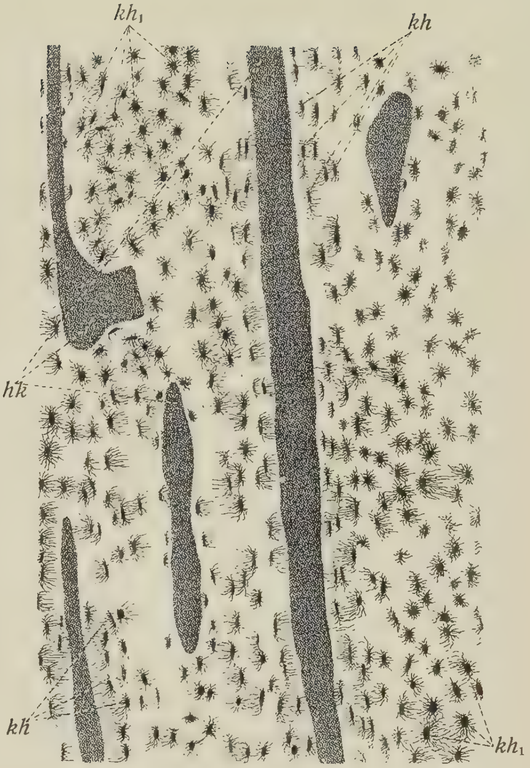

vk
agl
il
hk_1
hk
hl

Fig. 1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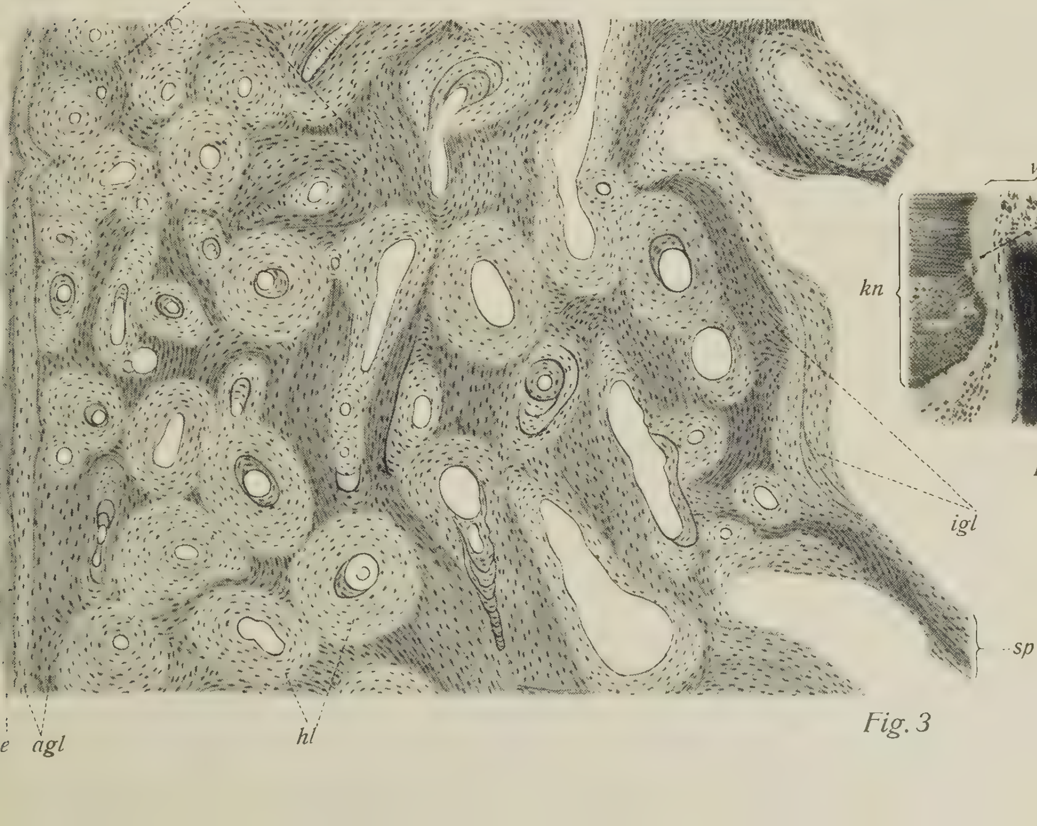
hk
kh
kh_1

Fig. 2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igl
sp
e
agl
hl

Fig. 3

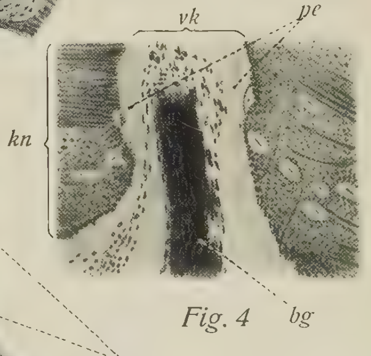


Fig. 4

Tab. 20

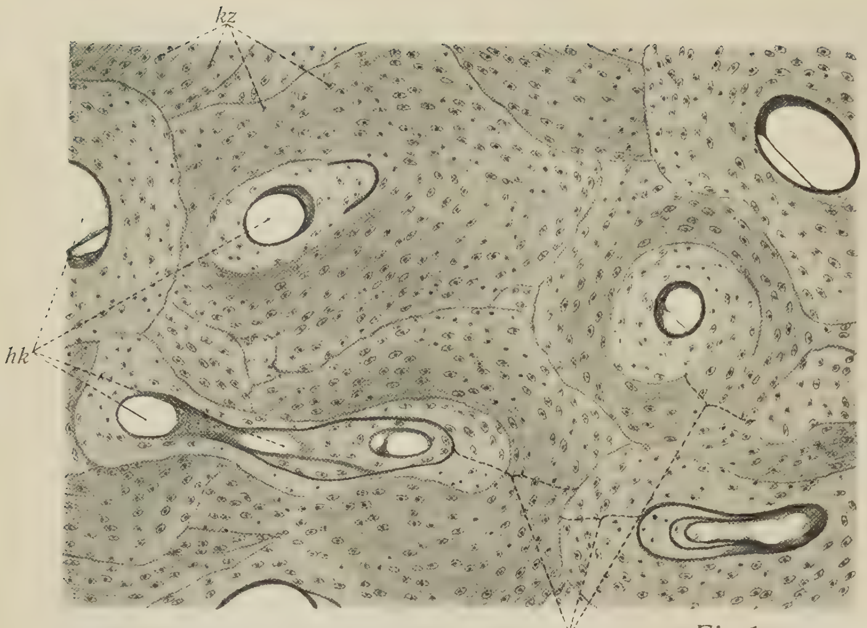


Fig. 1

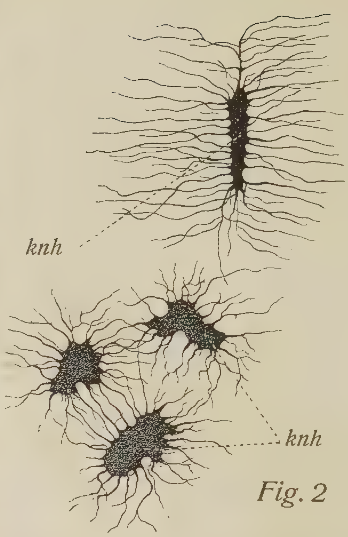
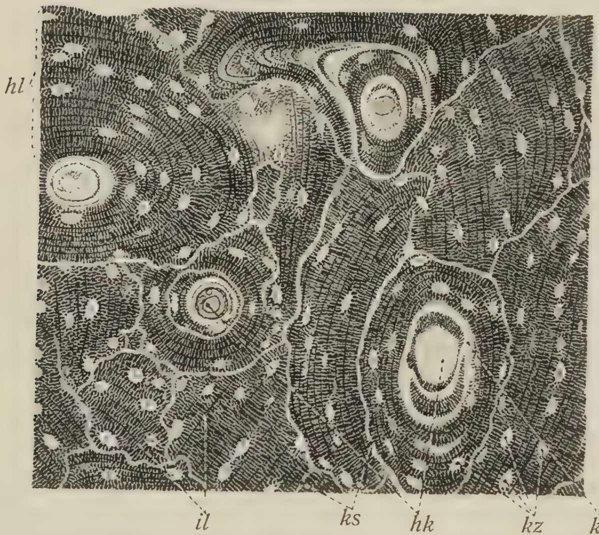


Fig. 2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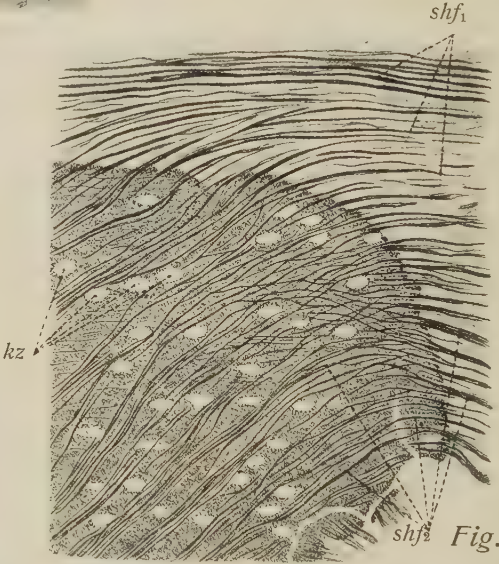
hk
kz
ks

Fig. 3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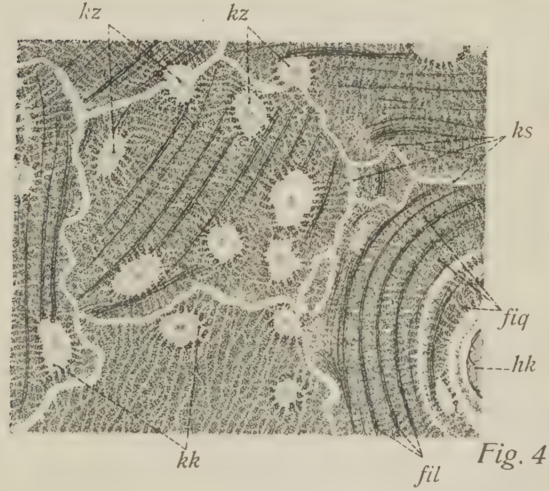
shf_2

Fig. 5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fiq
hk
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fil

Fig. 4

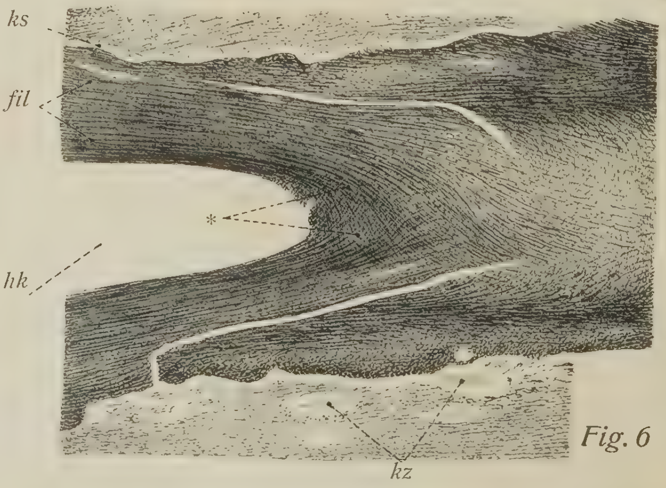

Fig. 6

Plate 20. **Bone II.**

Fig. 1. Part of a **Transverse Section from a Decalcified Tubular (Long) Bone (Human). × 100.** The figure shows a number of empty Haversian canals, and surrounding them the concentric lamellae, the inner of which are less darkly stained than the outer. In addition there are scattered areas of interstitial lamellae, particularly a dark colored area in the upper part of the figure. The shrunken bone cells are clearly visible within the lacunae, and the latter within the lamellae. **Technique** as for Pl. 19, *Fig. 3.*

Fig. 2. **Lacunae and Canaliculi** from a Ground Section of a Tubular (Long) Bone (Human). × **700.** They appear black by transmitted light. The upper lacuna is cut longitudinally and viewed edgewise; the others are seen in surface view. **Technique** as for Pl. 19, *Fig. 1.*

Fig. 3. Part of a **Transverse Section of a Tubular (Long) Bone with the Fibrils Stained Intensely (Human).** × **150.** General picture of the fibrillar structure of bone, the dark tone of the figure being due to the depth of stain in the fibrils. The individual fibrils are not to be distinguished with low magnification but the general direction of the bundles in which they are arranged may be detected. Matrix free from fibers separates the individual lamellar systems. The lacunae appear clear, the bone cells lying in them are grey. Even with low magnification the change in direction of the fiber bundles of two neighboring lamellae is evident (see *Fig. 4*). **Technique:** The Bielschowsky-Studnicka method for fibrils.

Fig. 4. Part of the same preparation as pictured in *Fig. 3*, but under higher magnification (× **400**). The area is from the lower left part of *Fig. 3* but is rotated 90° clockwise. **Typical Fibrillar Picture** of bone. Haversian and interstitial lamellae are seen. The lacunae appear clear, within them are the shrunken bone cells. The immediate wall of a lacuna (the so-called bone capsule) is formed of matrix free from fibrils. Some fibrils being cut across appear as fine points, others cut lengthwise as fine lines, both are always arranged in bundles. Each bundle consists of only a few fibrils (bone of fine bundles). The individual bundles of fibrils are separated by fine lines of matrix free from fibrils. Note that with relatively great regularity the fibrils of two neighboring lamellae are arranged at right angles to one another. **Technique** as for *Fig. 3.*

Fig. 5. Part of a Section of a **Decalcified Bone and Suture** from the **Human Skull. Sharpey's Fibers.** × **220.** Above is periosteal tissue, at the right that of the suture. It is seen how Sharpey's fibers, arranged in larger or smaller bundles come from either the periosteal tissue or from that of the suture and enter the bone in great numbers. The lamellar structure of the bone shows indistinctly, its own fibrils are paler and less clearly visible than the fibers of Sharpey. **Technique** as for *Figs. 3 and 4.*

Fig. 6. Part of a **Longitudinal Section of a Decalcified Tubular (Long) Bone with the Fibrils Stained (Human).** × **320.** The section passes obliquely across the wall of an Haversian canal and shows the abundance of fibrils recognisable in the concentric lamellae surrounding it. **Technique** as for *Figs. 3 to 5.*

fil = bundles of fibrils cut lengthwise
fiq = bundles of fibrils cut across
hk = Haversian canals
hl = Haversian lamellae
il = interstitial lamellae
kk = bone capsules
knk = lacunae
ks = lines of cement
kz = bone cells
shf_1 = Sharpey's fibers in periosteum and suture
shf_2 = Sharpey's fibers in bone
* = decussation of fibrils

Plate 21. **Development of Bone I.**

Fig. 1. A Section through a Human **Haversian Canal** and Its Immediate Surroundings. × **220.** In the canal are some marrow cells, a wide vein devoid of muscle, small arteries and connective tissue that is rich in cells.

Figs. 2—4. **Replacement of Cartilage by Bone in the Skeleton of an Embryonic Limb.** Stage I. *Figs. 2 and 3,* × **80;** *Fig. 4,* × **500.**

Fig. 2. First Stage. Longitudinal section of a middle phalanx of a human embryo of three months. The cartilaginous portion of the phalanx is characterized by a bluish violet color; its middle region is surrounded by a thin layer of perichondral bone stained red. This layer is thickened in the middle and is undergoing calcification. The lacunae in the cartilage are enlarged.

Fig. 3. Part of a longitudinal section of the basal phalanx[1] of a similar finger. Beginning of the disintegration of the cartilage and further advance of the perichondral ossification. The articular extremity of the phalanx consists entirely of embryonic hyaline cartilage (light blue-violet). The arrangement of the cartilage cells in rows begins in advance of the margin of the perichondral shell of bone. Then the zone of calcification of the cartilage matrix begins (the bluish violet becomes decidedly deeper in tone) and accompanying this change the cartilaginous lacunae enlarge and the cartilage cells shrivel up. In the middle of the phalanx the lacunae of the cartilage are being broken down through the activity of osteoclasts; and resorption of the calcified matrix (shown in dark blue-violet) is taking place, thus forming a primary marrow cavity. In this marrow cavity there lie, beside the remaining bars of calcified cartilage matrix, blood vessels, young marrow cells and polykaryocytic osteoclasts. The wider cartilage lacunae have broken open, a fact easily recognized from the number of nuclei in the larger spaces. The external layer of young perichondral bone matrix has grown thicker and extends toward the ends of the phalanx. There is as yet no endochondral bone.

Fig. 4. Part of the preparation pictured in *Fig. 2,* but under higher magnification. Note the enlarged lacunae in the calcified cartilage and the young bone matrix applied to the latter. The bone is as yet free from cells although osteoblasts lie on its outer surface.

Figs. 5—8. **Formation and Resorption of Bone** (cf. Pl. 22). × **420.** From the anlage of the mandible of a human embryo of seven months.

Fig. 5 shows a young bar of bone matrix (red) bordered by osteoblasts, some of which are caught in process of becoming fixed bone cells. *Fig. 6* shows a polykaryocytic osteoclast lying inactive in connective tissue. *Fig. 7* shows two giant cells (osteoclasts) in activity, a small piece of bone matrix (red) has already been largely absorbed. *Fig. 8* shows an osteoclast in an excavation it has made in a young piece of bone; Pl. 22, *Fig. 5* shows a similar picture with three active osteoclasts.

Technique: for *Figs. 1—8.* Müller's fluid—formol. Decalcification by nitric acid. Celloidin. Haemalum-eosin.

art = artery
bd = connective tissue
bg = blood vessel
kn = young bone matrix
kn_1 = zone of unaltered cartilage
kn_2 = zone of cartilage cells arranged in rows
kn_3 = zone of calcified matrix and enlarged cartilage lacunae
kn_4 = remnants of the walls of broken-down lacunae
knh = lacunae
kno = bone
knz = cartilage cells
kz = bone cells
kz_1 = osteoblasts in process of becoming bone cells
lknh = empty lacunae
mz = marrow cells
okl = osteoclasts
ostb = osteoblasts
pch(ph) = perichondrium
pe = periosteum
pk = perichondral bone
* = gap in perichondral shell of bone leading into the primary marrow cavity, polykaryocytic osteoclasts and marrow cells within the latter
ve = veins

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[1] This always precedes the distal phalanges in ossification.

Tab. 21

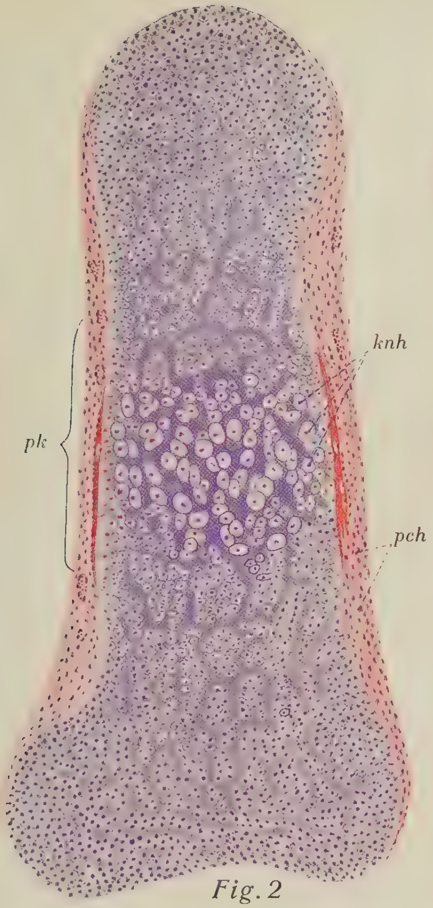


Fig. 2

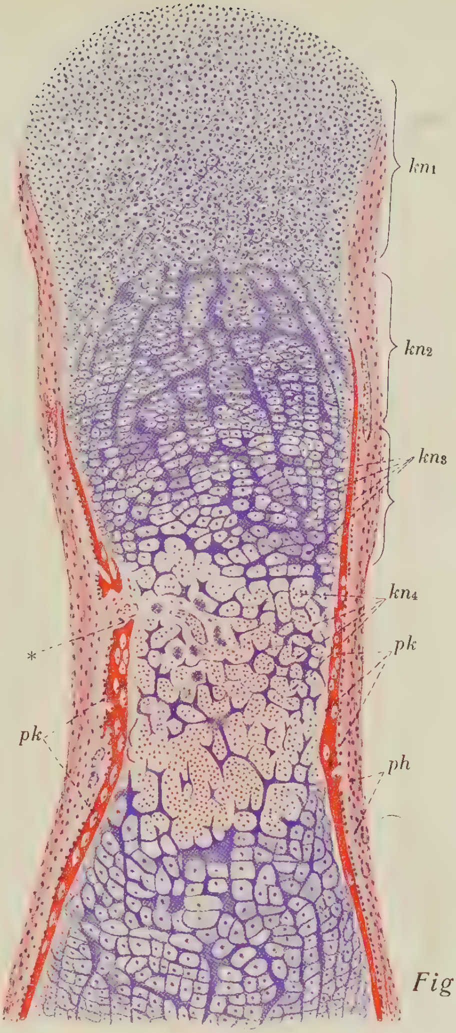

kn1
kn2
kn3
kn4
pk
*
pk
ph

Fig. 3

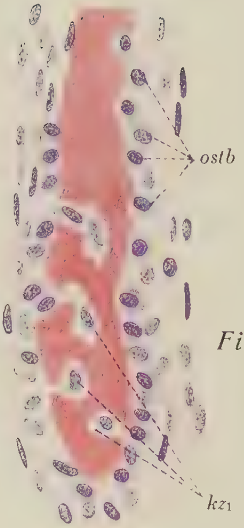


Fig. 5

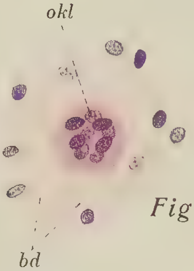
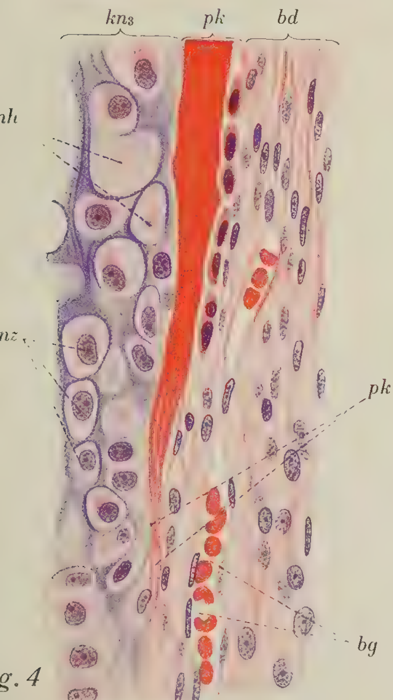


Fig. 6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pk
bd
nh
nz
pk
bg

g. 4

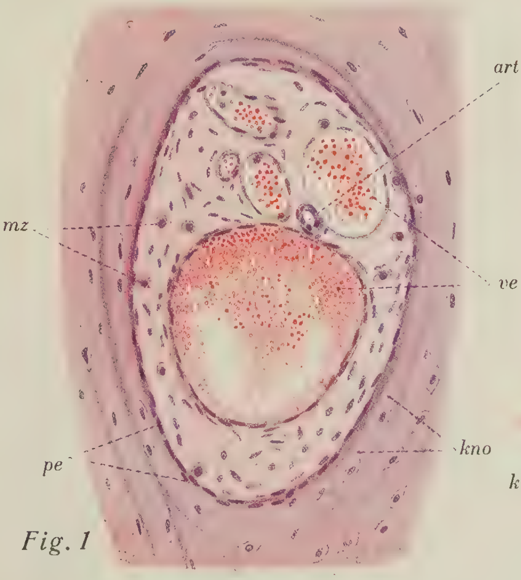

art
mz
ve
kno
pe

Fig. 1

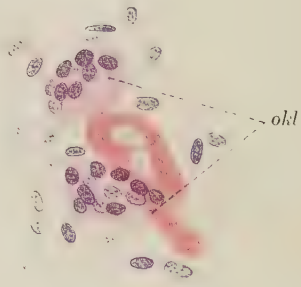


Fig. 7

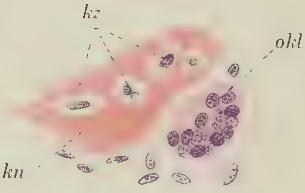
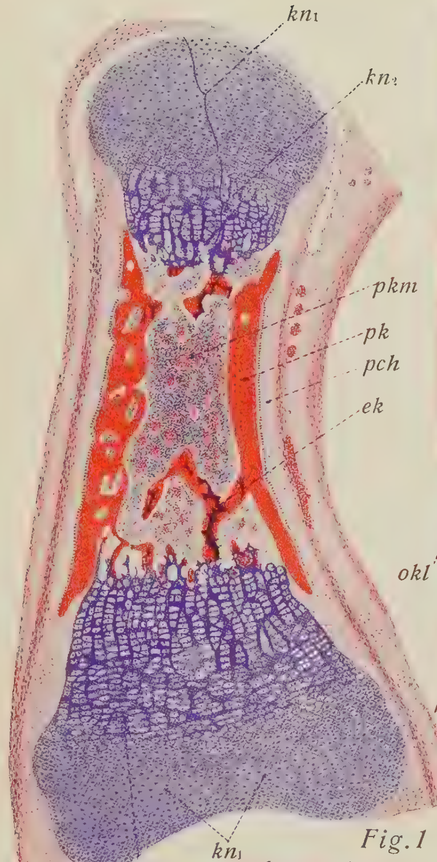


Fig. 8


kn_1
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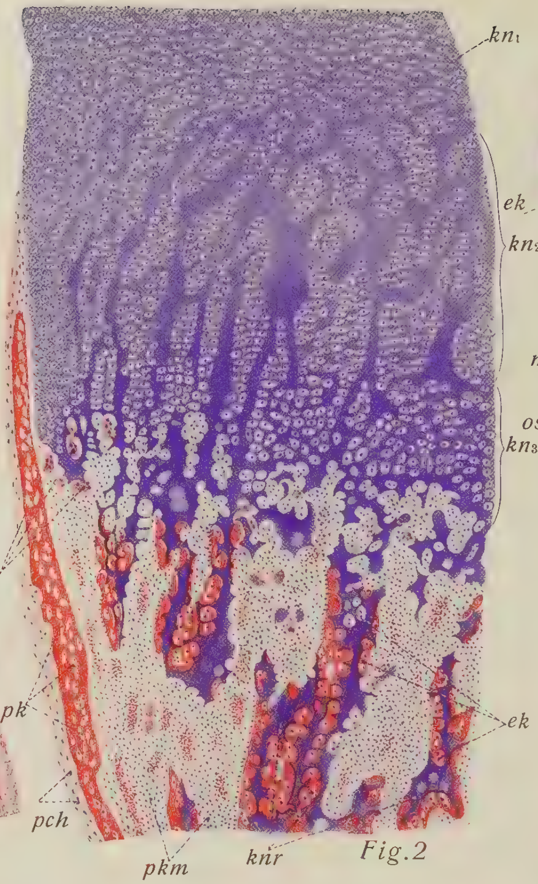
pk
pch
ek
kn_1

Fig.1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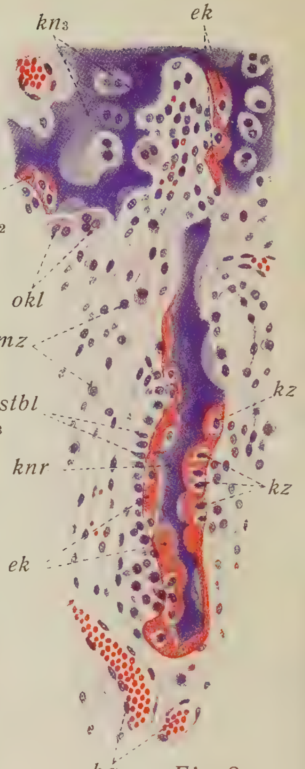
knr

Fig.2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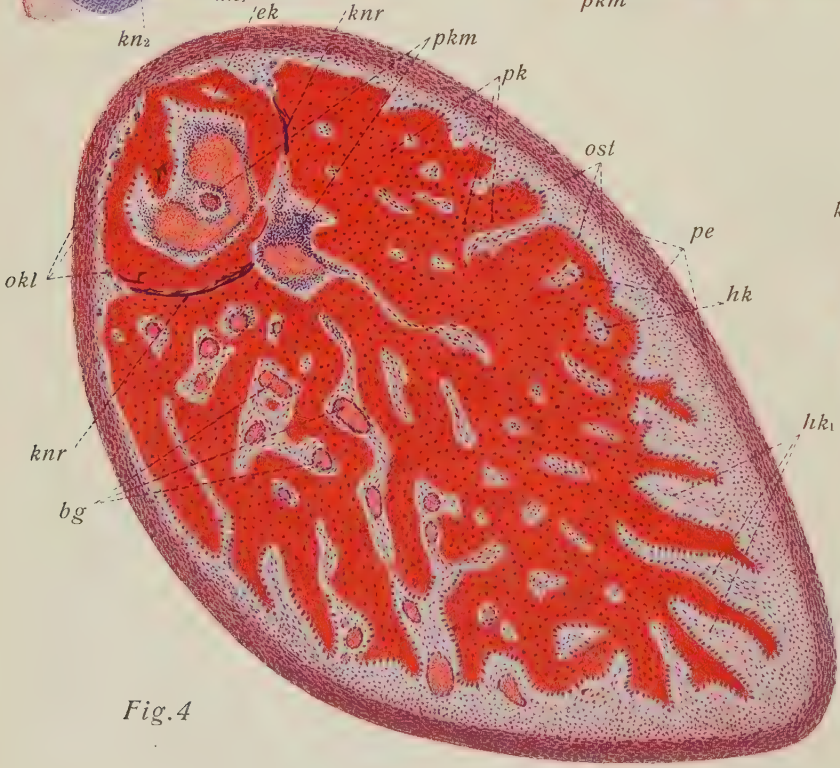
kz
ek
bg

Fig.3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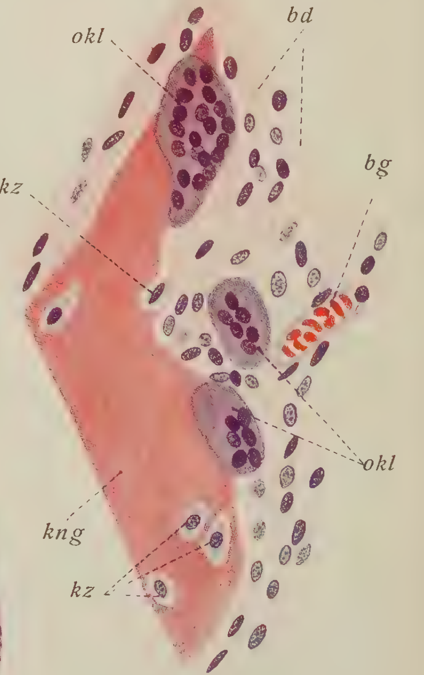
hk
hk_1
knr
bg

Fig.4


okl
bd
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kz
okl
kng
kz

Fig.5

Plate 22. Development of Bone II.

Fig. 1. **Development of Bone; Endochondral and Perichondral Bone** (Human Embryo of Five Months). × **20.** Longitudinal section through the middle phalanx of a finger. General view of the process of ossification in skeletal parts preformed in cartilage. The articular extremities of the phalanx represented are as yet pure hyaline cartilage; on the other hand in the central part of the phalanx the cartilage has already been entirely removed and in its place the primary marrow cavity has appeared. The perichondral bone forming the walls of this cavity is already a layer of considerable thickness; at both ends of the marrow cavity removal of the recently calcified cartilage is in progress. Uncalcified cartilage pale blue-violet, calcified cartilage dark blue-violet, bone matrix red. **Technique:** Müller's fluid—formol. Celloidin. Haematoxylin-eosin.

Fig. 2. **Endochondral and Perichondral Bone.** × **60.** Part of a longitudinal section of the same metacarpal bone as the above. The preparation embraces part of the zone of pure hyaline cartilage from the articular extremity, the entire zones of the calcification and dissolution of the cartilage and a part of the marrow cavity with its wall of perichondral bone and its bars of endochondral bone deposited upon the remains of the calcified cartilage matrix. The detail of *Fig. 1* is thus shown under greater magnification. **Technique** as for *Fig. 1.*

Fig. 3. Trabeculae of **Calcified Cartilage Matrix with Endochondral Bone** Deposited upon Them. × **180.** Detail of *Fig. 2.* There is seen a layer of endochondral bone matrix, very thin as yet, applied to the jagged edges of the bars of cartilage still remaining. Single osteoblasts are being surrounded by bone matrix and in this way are becoming fixed bone cells. Osteoclasts in the upper part of the figure are effecting a further removal of the calcified cartilage matrix. **Technique** as for *Fig. 1.*

Fig. 4. **Ossification of a Long Bone.** × **50.** Transverse section through a bone of the forearm of a human embryo of six months. The small marrow cavity is surrounded by the young bone, the greater part of which is of perichondral origin and appears entirely red because it contains no remains of cartilage matrix. Numerous Haversian canals are completed around blood vessels and others are in process of formation. Above and to the left lies the highly eccentric marrow cavity bounded by endochondral bone which is separated from the perichondral bone by a dark bluish-violet line of calcified cartilage matrix. Osteoclasts mark the rapid resorption of the endochondral bone. Note the covering of closely placed osteoblasts on the external surface of the periosteal bone, an appearance indicating the deposition of new bone. **Technique** as for *Fig. 1.*

Fig. 5. **Resorption of Bone in the Mandible** of a Human Embryo of Seven Months. × **420.** On the left is young bone (red); on the right is the embryonic connective tissue by the calcification of which the bone matrix is formed. Three multinucleate osteoclasts are seen, one of which is at rest, the other two lie in lacunae and are actively resorbing bone; note particularly the larger one above and its many nuclei. There are no osteoblasts on the bone since only resorption, not deposition is taking place. **Technique** as for *Fig. 1.*

bd = connective tissue
bg = blood vessels
ek = endochondral bone
hk = Haversian canals
hk_1 = Haversian canals in process of formation
kn_1 = unaltered hyaline cartilage
kn_2 = beginning of calcification of cartilage
kn_3 = zone of completely calcified cartilage and disappearance of cells
kng = bone matrix

knr = remains of cartilage matrix
kz = bone cells
mz = marrow cells
okl = osteoclasts
ost (ostbl) = osteoblasts
pk = perichondral bone
pkm = primary marrow cavity and tissue
pe = periosteum
ve = veins

Plate 23. **Blood Vessels I.**

Fig. 1. Part of a **Transverse Section** of a Small Branch of the Human **Coeliac Artery.** × **200.** General view of the microscopic structure of a typical artery of medium caliber as usually stained. The artery is clearly limited by its surrounding connective-tissue sheath (*bd*) which is followed externally (extreme left of the figure) by loose connective tissue. The elastica interna appears quite clear under this method of staining. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 2. Part of a Transverse Section of the Human **Radial Artery.** × **275.** General view of the division into layers of the wall of an artery of medium caliber. The tunica media is formed chiefly of smooth muscle. Elastic tissue is stained a brownish red; nuclei blue. **Technique:** Zenker's fluid. Celloidin. Orcein-haematoxylin.

Fig. 3. Part of a Transverse Section of the **Thoracic Aorta** (Human, aet. 21. Execution). × **50.** General view of the relations of the elastic elements (membranes) in the aorta. Only the elastic tissue is stained. **Technique:** Müller's fluid. Celloidin. Orcein.

Fig. 4. Section of a **Medium Mesenteric Artery** Giving off a Branch (Human, aet. 21. Execution). × **170.** The branch is cut lengthwise for a distance. The elastic tissue is not stained; the elastica interna appears in cross section as a clear wavy line. **Technique:** Müller's fluid—formol. Celloidin. Haematoxylin-eosin.

Fig. 5. **Capillaries** from Different Organs or Tissues of the **Human** Body. × **800.** The surrounding connective tissue is represented along with the capillary. Two capillaries are cut lengthwise and three are cut across. The lumina contain erythrocytes. Note the marked difference in caliber. The basal membrane appears red. Of the endothelium only the (blue-violet) nuclei are visible; differentiation between these nuclei and those of the surrounding connective tissue is not always easy. **Technique** as in *Fig. 1.*

Fig. 6. Part of a Section of the **Wall of the Heart** Cut Perpendicularly to its Surface (**Human,** Execution). × **120.** The endocardium and a part of the myocardium are to be seen. **Technique** as for *Fig. 1.*

bd = connective-tissue sheath of vessel
bk = nuclei of the pericapillary connective tissue
elai = membrana elastica interna
end = endothelium
endoc = endocardium
hmf = transverse sections of cardiac muscle fibers
ken = nuclei of capillary endothelium
ken$_1$ = nuclei of capillary endothelium which appear to lie external to the basal membrane
km = nuclei of smooth muscle
l = lumen
myc = myocardium
ta = tunica adventitia
ti = tunica interna
tm = tunica media
vv = vasa vasorum
* = wall of small artery cut tangentially

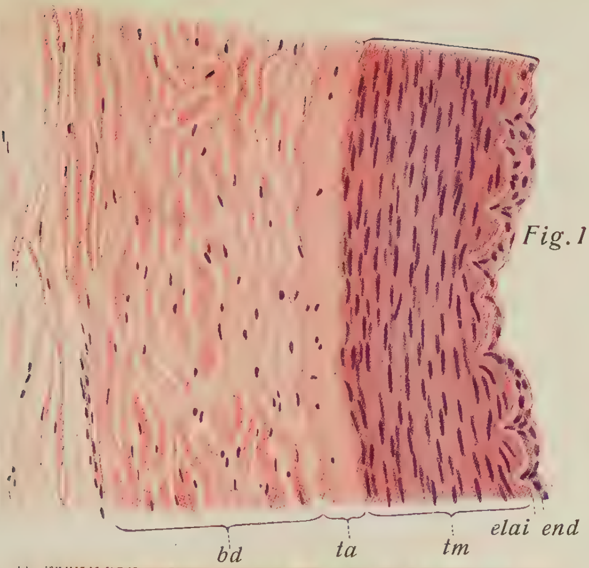
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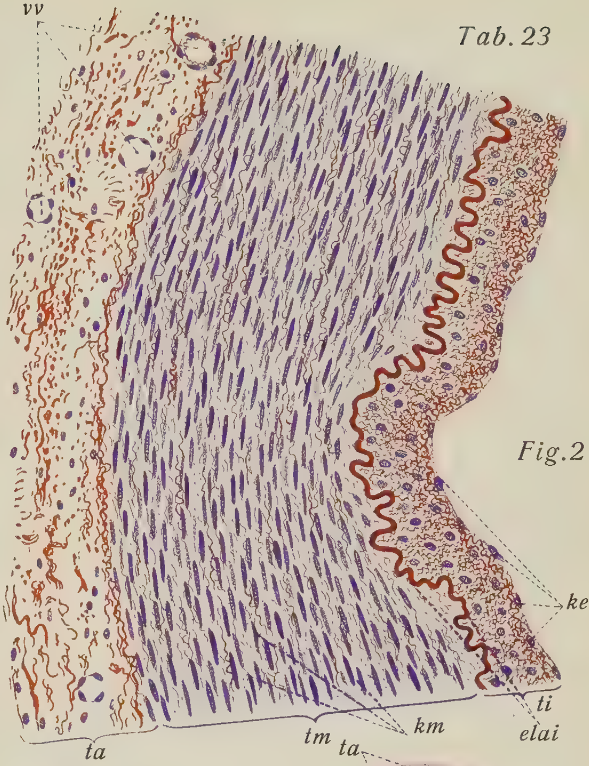
Fig. 1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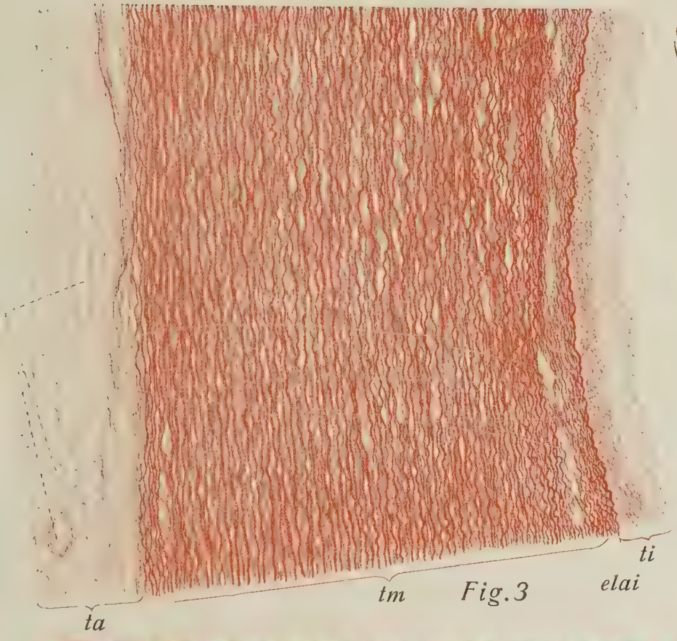
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Fig. 3

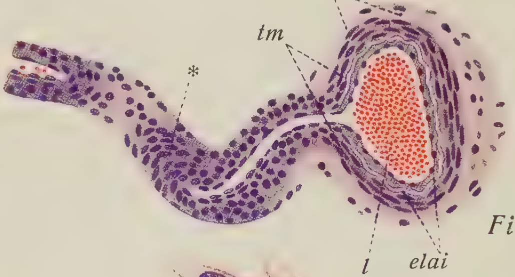

Fig. 4

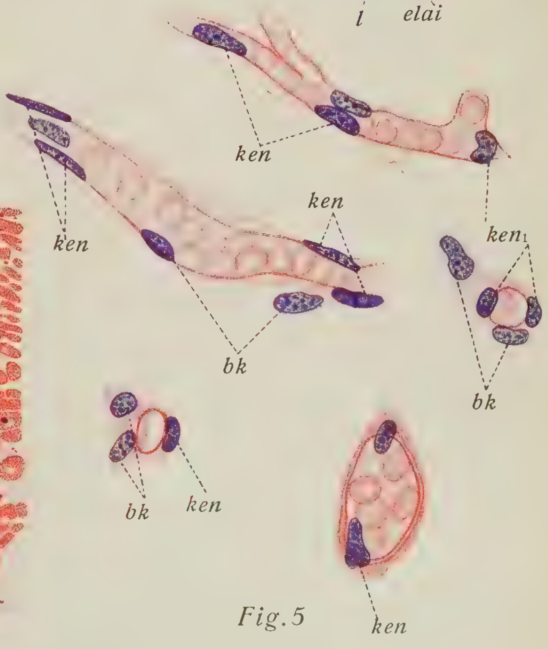
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Fig. 5

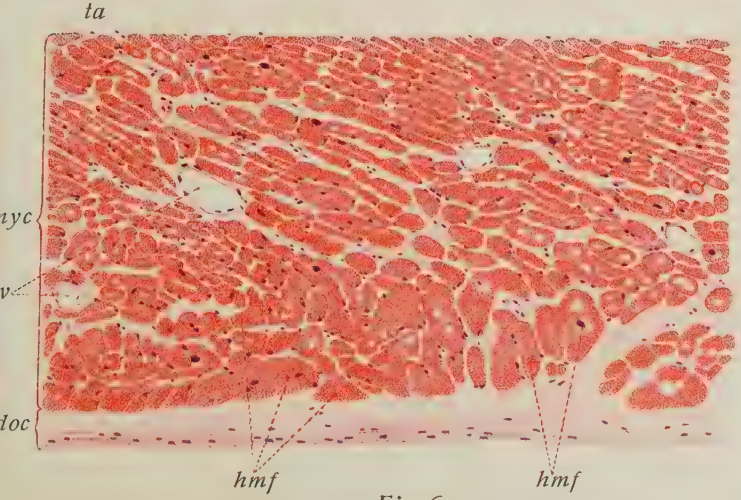
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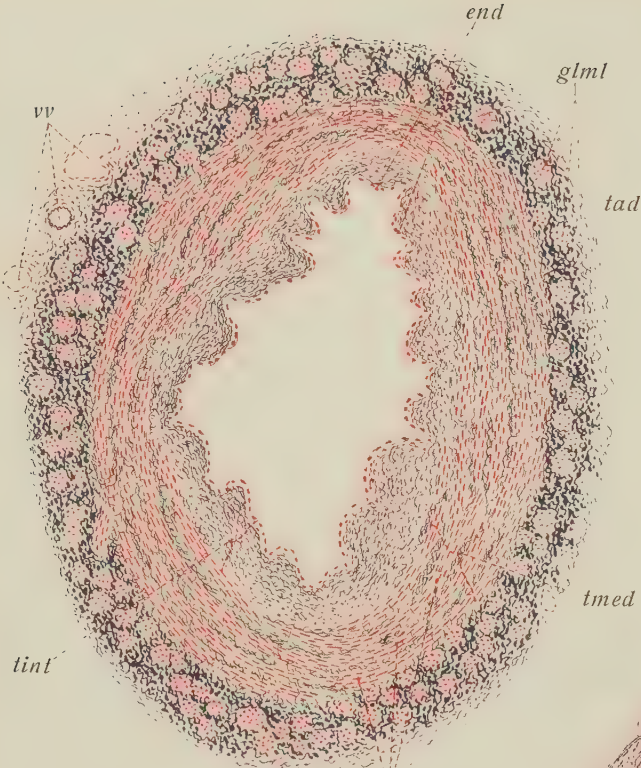
Fig. 6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vv
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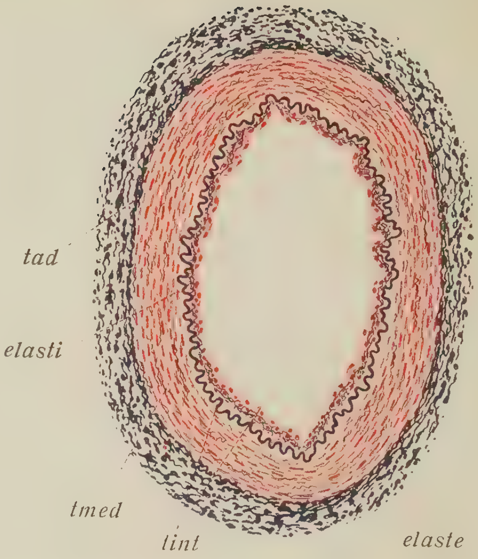
Fig. 1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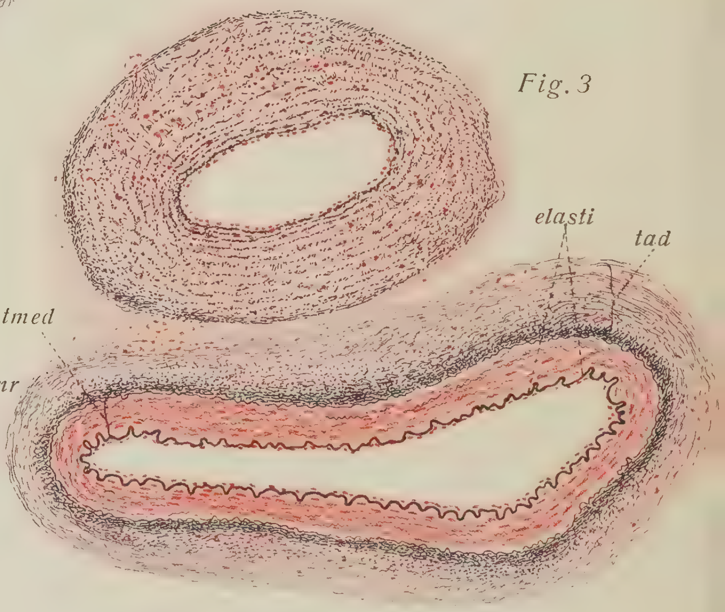
elaste

Fig. 2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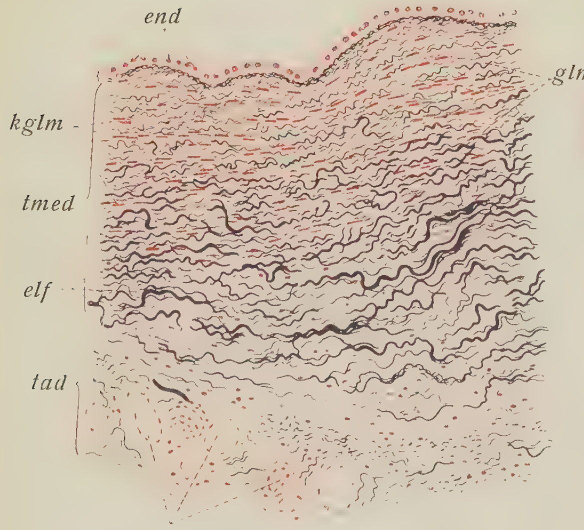
tad
tmed

Fig. 3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vv

Fig. 4

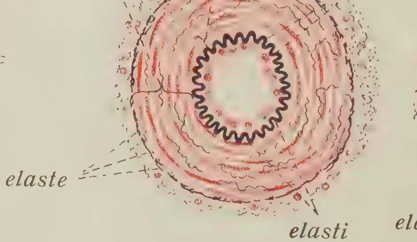
tint
tmed
endk
elaste
elasti

Fig. 5

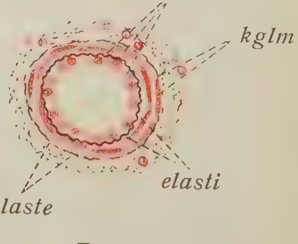
endk
kglm
elasti
elaste

Fig. 6

Plate 24. **Blood Vessels II.**

Fig. 1. Transverse Section of a **Vein** from the Pampiniform Plexus (Human, aet. 21. Execution). × **60.** The tunica media is provided **with unusually large bundles of muscle** arranged circularly and separated by connective tissue and elastic fibers. The tunica externa contains longitudinal muscle and much elastic tissue. The boundaries of the three coats are not sharply marked; the intima is rather thick. **Technique:** Zenker's fluid. Celloidin. Weigert's elastin stain. Paracarmine.

Fig. 2. Transverse Section of a **Small Artery** (Human, aet. 22, Execution). × **80.** One of the larger branches of the internal spermatic artery from the spermatic cord. The tunica media consists almost entirely of muscle and is sharply bounded on both sides by the internal and external elastic membranes. Elastic tissue dark violet, nuclei red. **Technique** as for *Fig. 1.*

Fig. 3. Transverse Section of a **Small Artery and Accompanying Vein** from the Pelvis Minor (Human, aet. 22. Execution). × **125.** The elastic tissue is stained an intense violet. The artery is quite empty and collapsed. The tunica media consists almost entirely of muscle and is separated from the inner coat of the vessel by a well marked elastica interna. In contrast to the artery the vein does not show an equally sharp demarcation of its three coats as regards either the muscular or the fibro-elastic elements of the vessel wall. **Technique** as for *Fig. 1.*

Fig. 4. Part of a Transverse Section of the **Femoral Vein** (Human, aet. 21. Execution). ×**110.** Example of a vein with little muscle in its wall. The muscle is restricted to scattered bundles separated by considerable connective tissue containing elastic fibers. The tunica externa is devoid of muscle; the tunica interna is very thin. **Technique** as for *Fig. 3.*

Fig. 5. Transverse Section of a **Small Human Artery.** × **170.** (A branch of the internal spermatic artery.) The tunica media consists almost entirely of muscle but contains fine elastic fibers. It is bounded on the side toward the intima by a strong elastica interna. **Technique** as for *Fig. 1.*

Fig. 6. Transverse Section of a Human **Precapillary Arteriole.** × **220.** (From the corium of the skin.) The tunica media is formed of a few muscle fibers without elastic fibers. The elastica interna and in part the elastica externa are visible. **Technique** as for *Fig. 1.*

elaste = tunica elastica externa
elasti = tunica elastica interna
elf = elastic fibers
end = endothelium
endk = nuclei of endothelium
glml = longitudinal smooth muscle
glmr = smooth muscle arranged circularly
kglm = nuclei of smooth muscle cells
tad = tunica adventitia (externa)
tint = tunica interna
tmed = tunica media
vv = vasa vasorum

Plate 25. **Lymph Gland, Spleen I.**

Fig. 1. Section of a Small **Cervical Lymph Gland** (Human, aet. 28. Execution). × **18.** General view of the structure of a lymph gland. There are to be recognized the capsule and trabeculae, the cortex and the secondary nodules, the medulla with its medullary cords and lymph sinus; beneath is the hilum. **Technique:** Sublimate. Paraffine. Haematoxylin-eosin.

Fig. 2. **Central Area of a Secondary Nodule** from a Lymph Gland (Human. Execution). × **270.** The germinal center is seen and the region of the secondary nodule immediately adjacent. Within the germinal center are relatively large lymphoblasts with mitotic figures. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Section from the **Spleen (Human,** aet. 22. Execution). × **22.** General view of capsule, trabeculae and trabecular vessels, and of the splenic corpuscles scattered at almost equal distances throughout the splenic pulp. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 4. Part of a Section of **Human Splenic Pulp.** × **375.** Detail of the previous preparation. In addition to the tissue of the pulp a few narrow splenic sinuses are shown and one wider sinus is cut longitudinally for some distance. Two sheathed arteries are also seen. Note the erythrocytes (red) lying free in the pulp. The circular fibers of the basal membrane of the sinus wall appear like red hoops when cut lengthwise and as points when in cross section. **Technique** as for *Fig. 3.*

Fig. 5. **Pulp Tissue from the Human Spleen.** × **750.** Among the splenocytes there are clearly seen some which have phagocytosed red blood corpuscles and are digesting them. In particular toward the upper part of the figure a splenocyte is to be recognized containing an erythrocyte within its protoplasm. **Technique** as for *Fig. 3.*

artc = arteria centralis
ca = capsule
end = endothelial cells of splenic sinus
ha = sheathed arteries
hi = hilum
kc = germinal center
lc = colorless blood cells
lc_1 = colorless blood cells in diapedesis through sinus wall
lc_2 = eosinophilic leucocyte
nl = secondary nodules
nll = splenic corpuscles
pu = splenic pulp
sc = cortex
si = lymph sinus
sin = splenic sinus
siw = wall of sinus
sm = medulla
spc, *splc* = splenocytes
$splc_1$ = splenocyte containing red blood cells
tr = trabecula
vetr = trabecular vein
* = zone of young lymphocytes surrounding the germinal center
+ = red blood corpuscles passing through the wall of the sinus

Tab. 25

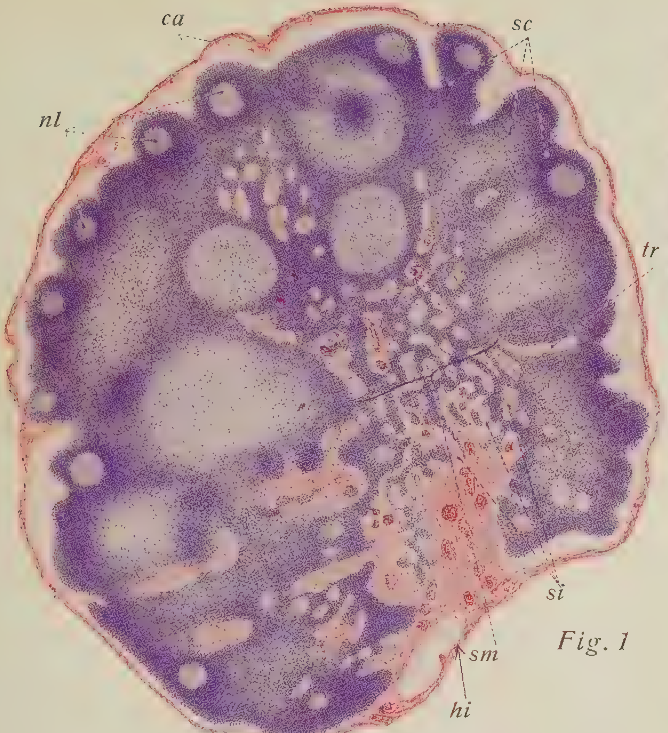
ca
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Fig. 1

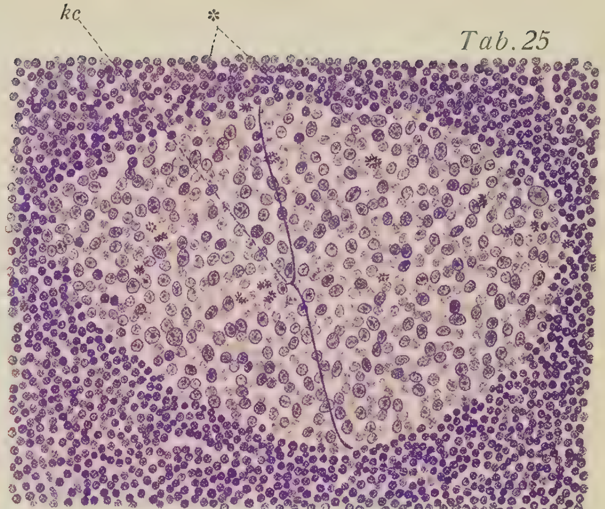
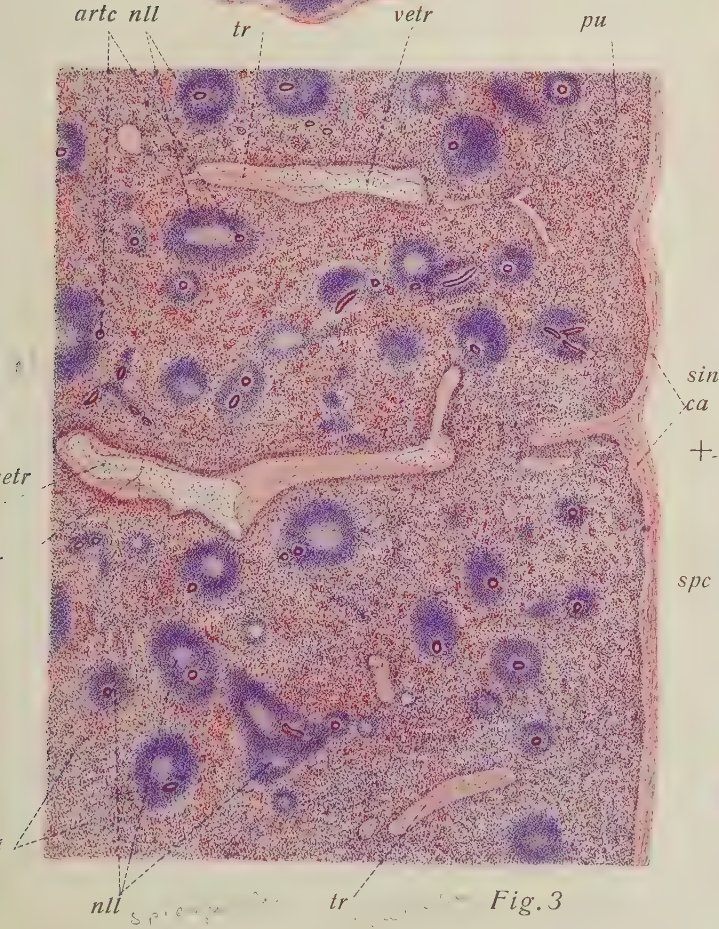


Fig. 2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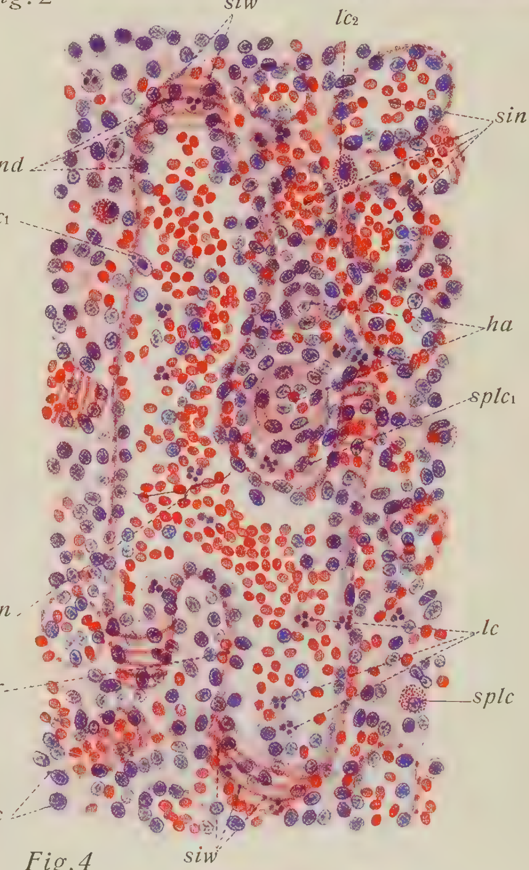
vetr
nll
tr

Fig. 3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lc₁
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Fig. 4

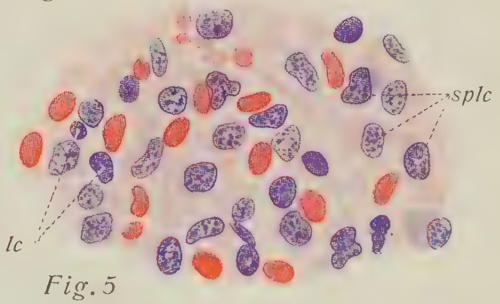

Fig. 5

Tab. 26

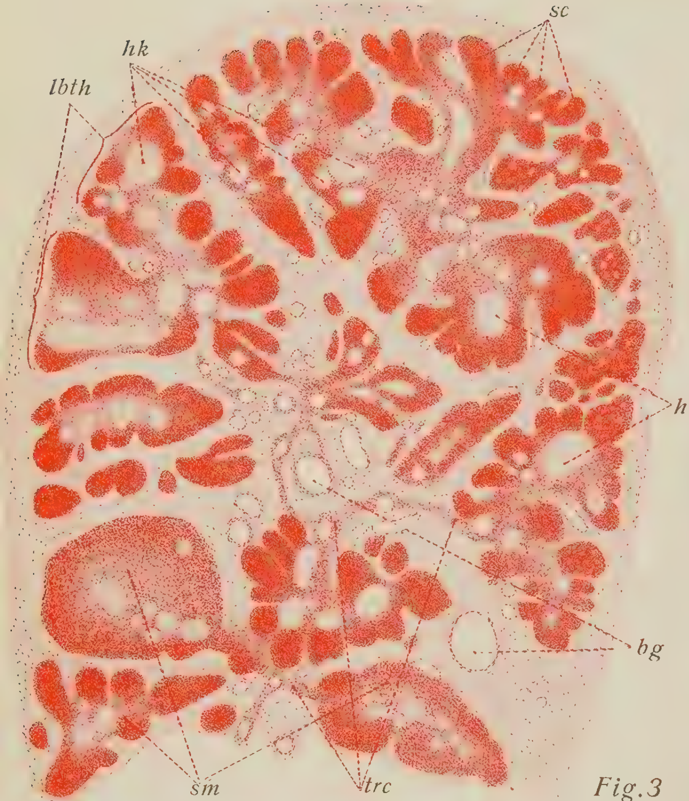
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Fig. 3

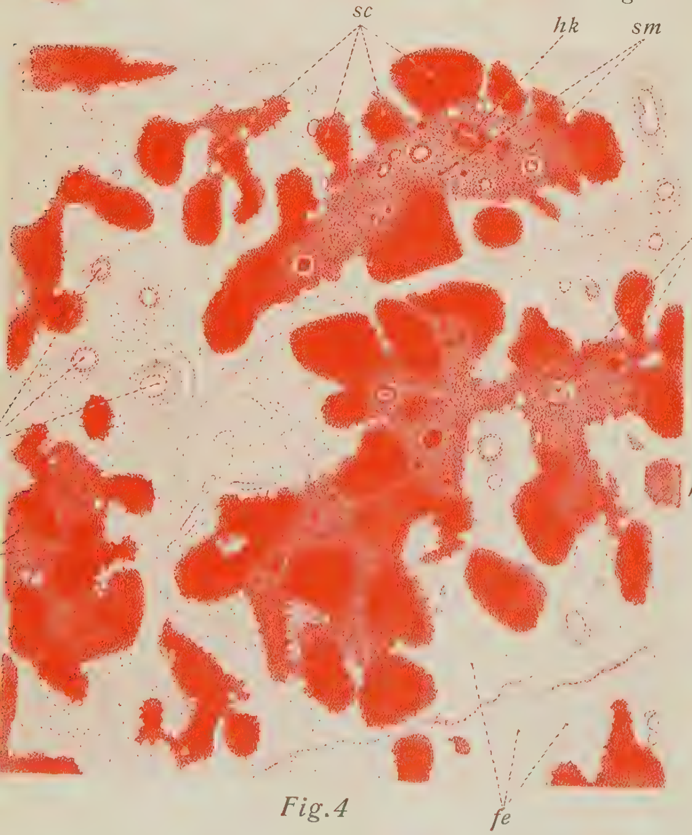
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Fig. 4

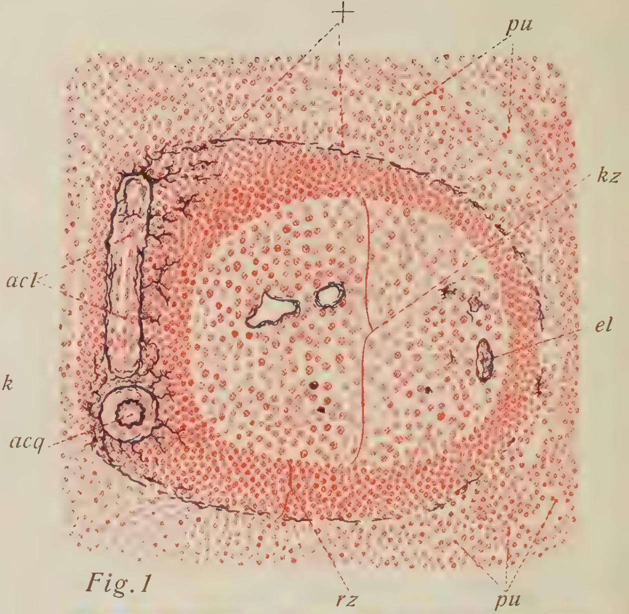
+
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Fig. 1

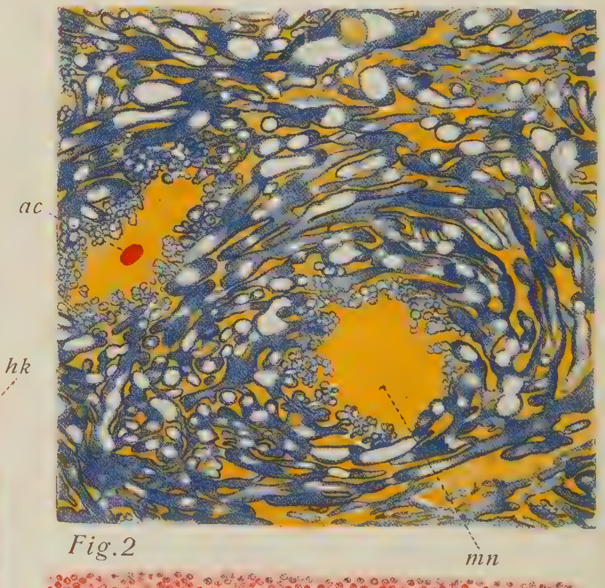


Fig. 2

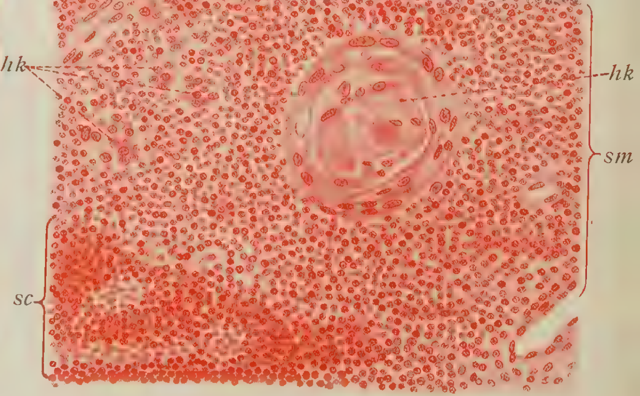


Fig. 5

Plate 26. **Spleen II, Thymus.**

Fig. 1. **Splenic Corpuscle** with Surrounding Splenic Pulp (Human, aet. 22. Execution). × **200.** The unusually large germinal center is surrounded by a dense border of small cells which are marked off from the surrounding pulp tissue by a thin layer of fine elastic fibers. At the left, and within the border, lies the central artery cut across (below) and also lengthwise (just above). **Technique:** Zenker's fluid. Celloidin. Weigert's elastin stain. Alum carmine.

Fig. 2. Part of a Section from an **Injected Spleen** (Rabbit). × **28.** Within the pulp are seen two splenic corpuscles (yellow) in one of which is an injected (red) central artery. In the pulp are numerous wide veins (splenic sinuses) filled with a blue mass. **Technique:** Müller's fluid. Double injection, arteries red, veins blue. Celloidin.

Fig. 3. Part of a Section from the **Thymus** (Child, 14 months). × **25.** General view of the structure of the organ at the time of its highest development. A connective-tissue capsule surrounds the organ, the loosely arranged lobules of which are of rather irregular form and are seen to be connected by the central tract. In the lobules the pale medulla with Hassall's corpuscles, and the darker, small-celled cortex are easily distinguished in spite of the low magnification. Numerous blood vessels. Adipose tissue is completely lacking in the thymus during youth. **Technique:** Müller's fluid. Paraffine. Alum carmine.

Fig. 4. Part of a Section from the **Thymus** of an **Adult.** Involution has begun (Human, aet. 23. Execution). × **25.** Note, in contrast to the condition in the new born, the marked separation of the lobules by large masses of adipose tissue. The cortex is much more affected by the atrophy than is the medulla; the latter is already in extensive contact with the interstitial adipose tissue. Hassall's corpuscles in the medulla are very distinct. **Technique:** Zenker's fluid. Borax carmine. Celloidin.

Fig. 5. Part of a Section of a Lobule from the **Thymus of a Child.** × **230.** The paler medulla (above in the figure) is clearly distinguishable from the denser cortex (lower left in the figure) with its closely set, small cells. In the medulla beside some small corpuscles of Hassall is one which although larger is only of average size. Note the external, concentric, nucleated layers of the structure and the central mass of irregularly aggregated remains of cells. **Technique** as for *Fig. 4.*

ac = central artery
acl = central artery cut lengthwise
acq = central artery cut across
bg = blood vessels
el = elastic fibers surrounding the wall of capillaries within the corpuscle
fe = adipose tissue
hk = Hassall's corpuscles
kz = germinal center
lbth = lobules of the thymus
mn = splenic corpuscle
pu = splenic pulp
rz = marginal zone of nodule
sc = cortex
sm = medulla
trc = central tract
+ = elastic fibers surrounding the periphery of the corpuscle

Plate 27. **Muscle and Tendon I.**

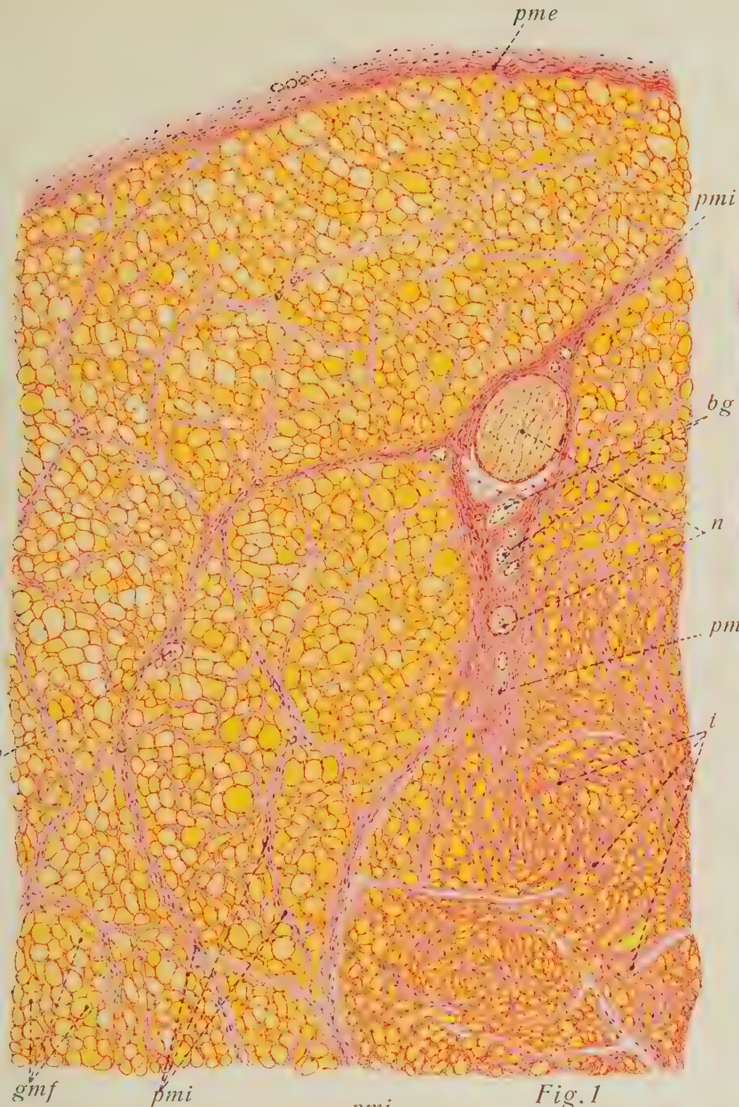
Fig. 1. Part of a Transverse Section of the Middle Region of the Human **Omohyoid Muscle.** × **53.** General view of the structure of the muscle. The arrangement of muscle fibers into fasciculi is seen and the relations of the perimysium, and of the nerves and vessels. At the right and below the tendon is beginning to appear; the muscle fibers are scattered between the tendon bundles and have become much thinner. **Technique:** Müller's fluid. Celloidin. Van Gieson's haematoxylin-picrofuchsin method.

Fig. 2. Part of the Same **Transverse Section of Muscle** as that of *Fig. 1.* × **300.** The figure shows a number of cross sections of striated muscle fibers, some with abundant sarcoplasm and distinct muscle columns, others with scanty sarcoplasm. The perimysium internum is visible; while delicate connective-tissue sheaths around the individual muscle fibers and narrow capillaries between them may also be seen. Beneath is a muscle spindle with its connective-tissue sheath and slender muscle fibers containing centrally placed nuclei. **Technique** as for *Fig. 1.* (Cf. Pl. 12, *Fig. 7.*)

Fig. 3. Part of a Transverse Section of a Human **Tendon.** × **45.** The figure shows clearly the formation of the larger, secondary tendon bundles by sheets of loose connective tissue which contain the relatively few blood vessels. Under this magnification the tendon cells appear as mere points. **Technique:** 70—90% Alcohol. Sectioned by razor. Haematoxylin-eosin. Excellent pictures of tendon are obtained by mounting unstained sections in glycerine but the nuclei will not be visible.

Fig. 4. Part of the Same **Transverse Section of Tendon** as that of *Fig. 3.* × **80.** (Cf. Pl. 9, *Figs. 1 and 2.*) The figure includes four secondary (coarser) tendon bundles and shows particularly well their sheaths (*psb* at the left of *Fig. 4*) formed of loose connective tissue and also the primary bundles defined by well marked projections from the tendon cells. **Technique** as for *Fig. 3.*

bd = connective tissue
bg = blood vessels
cap = capillary
hmsp = sheath of muscle spindle
kmf = nuclei of muscle fibers
mf = muscle fibers
mfsp = muscle fibers of muscle spindle
msp = muscle spindle
n = nerves
nf = nerve fiber
pme = perimysium externum
pmi = perimysium internum
psb = primary tendon bundles
psb (Fig. 4, left) = sheaths of secondary tendon bundles
sl = sarcolemma
ssb = secondary tendon bundles
sz = tendon cells
t = tendon


pme
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pmi
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gmf
pmi

Fig. 1

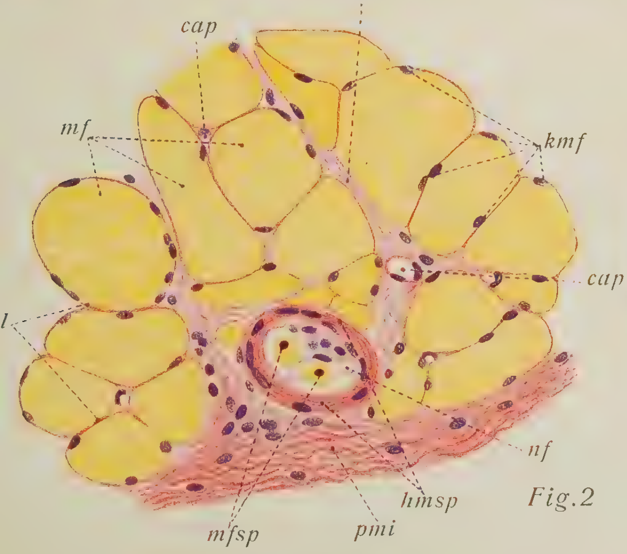
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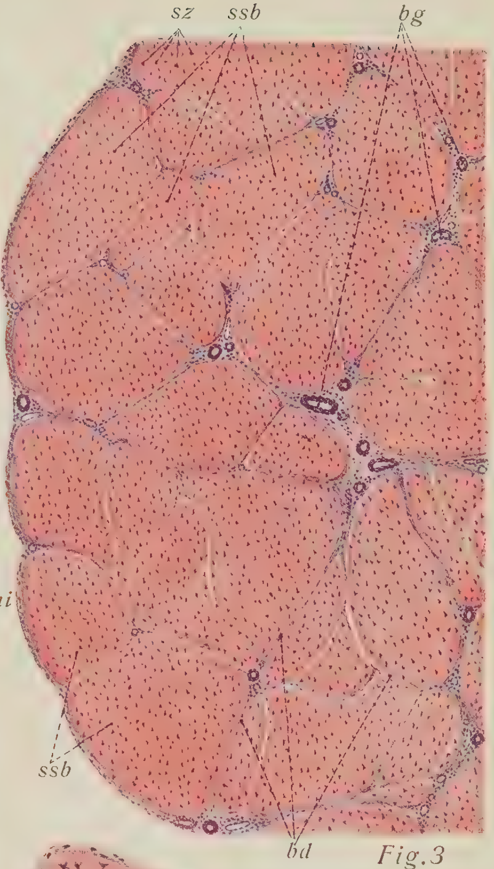
Fig. 2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bg
ssb
bd

Fig. 3

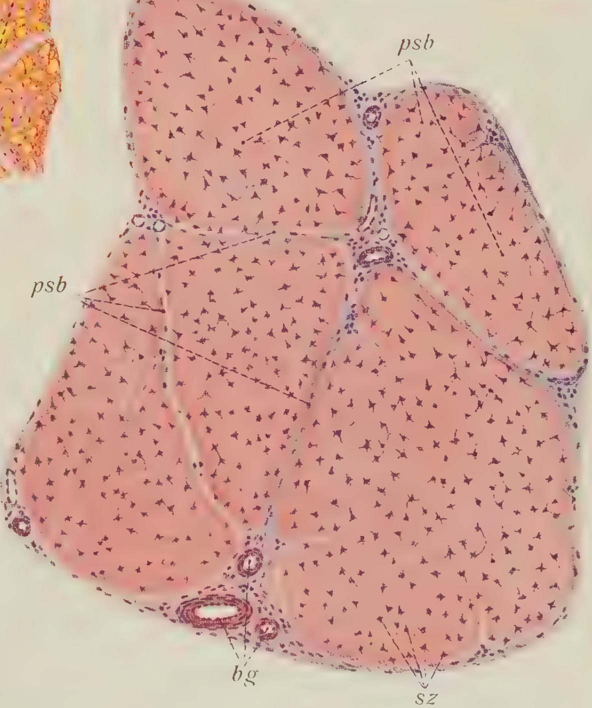
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Fig. 4

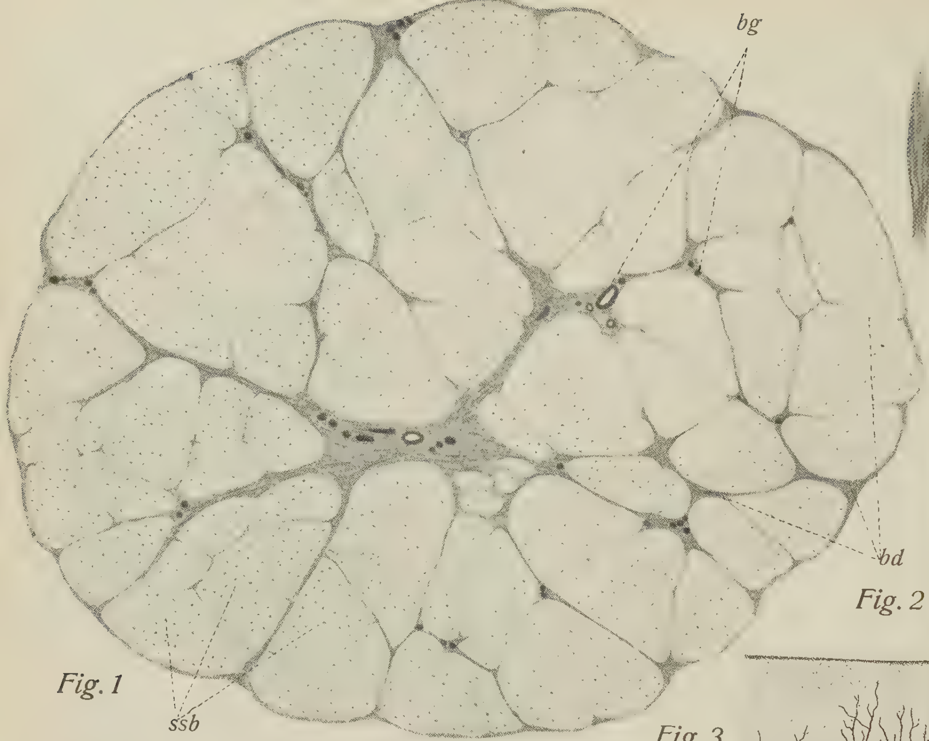

Fig. 1

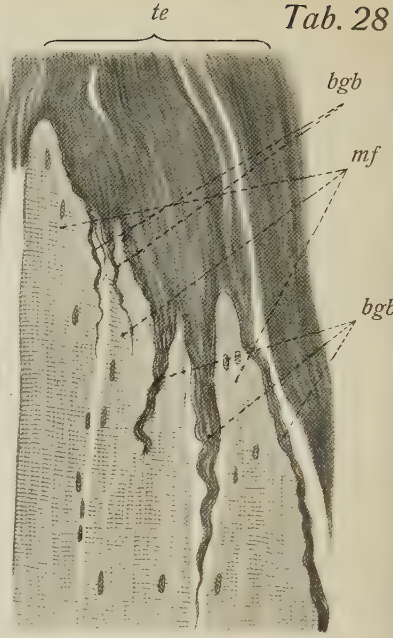
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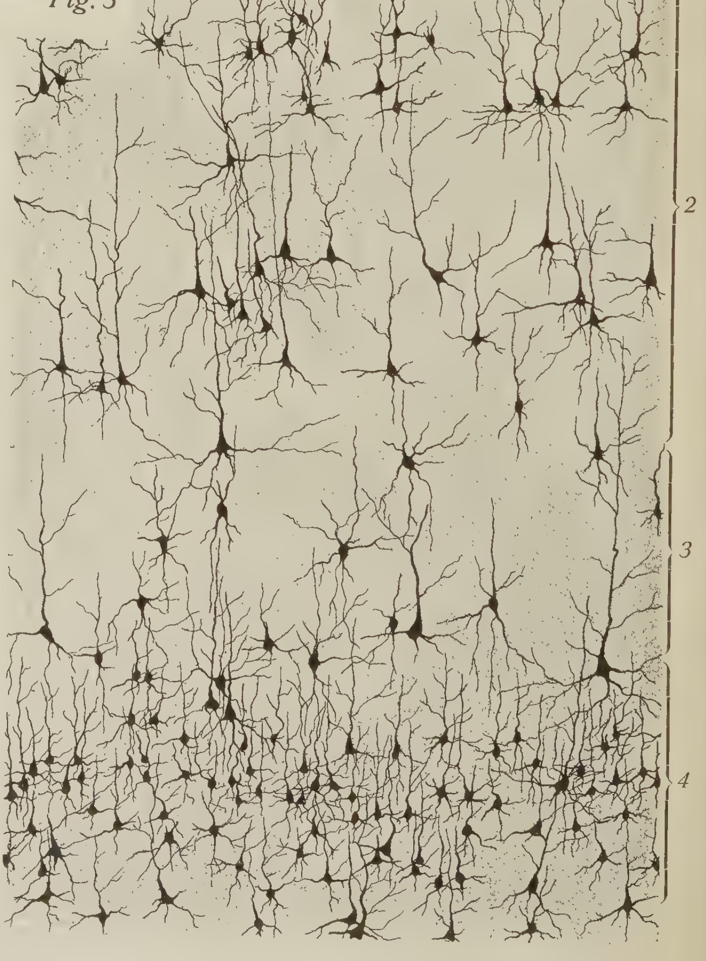
Fig. 2

Fig. 3



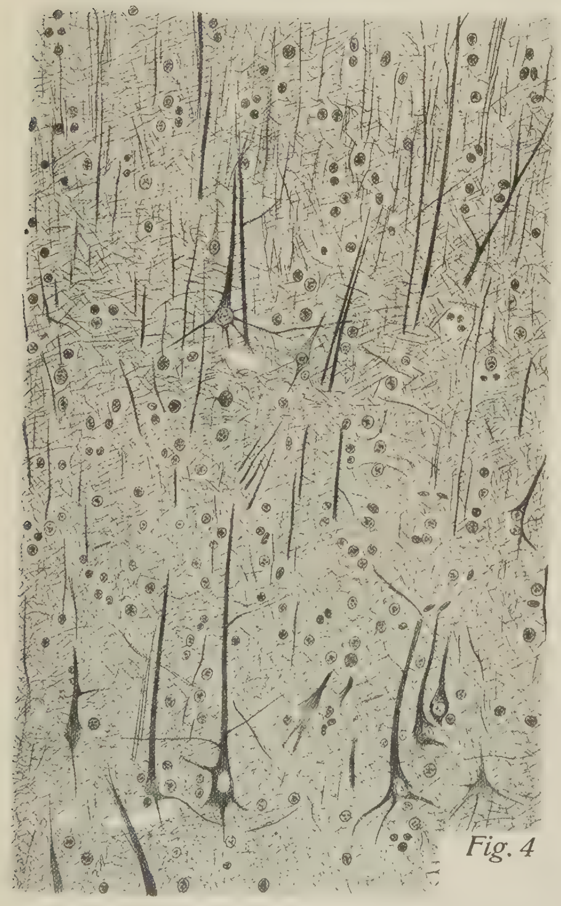


Fig. 4

Plate 28. **Muscle and Tendon II, Cerebral Cortex I.**

Fig. 1. Transverse Section of a **Human Tendon.** × **50.** The characteristic picture of the cross section of a tendon showing how connective tissue marks off polygonal areas which represent the individual secondary bundles. Under the magnification employed the tendon cells appear only as points (cf. Pl. 27, *Fig. 3*). Note how few blood vessels are contained in the tendon. **Technique:** Müller's fluid. Celloidin. Mounted in glycerine.

Fig. 2. **Junction of Muscle and Tendon (Human).** × **300.** A few striated muscle fibers are seen cut longitudinally; their ends toward the tendon are narrowed. The connective tissue of the tendon is stained quite dark. The embedding of the ends of the muscle fibers in the connective tissue of the tendon is clearly shown, also the direct continuation of the latter into the perimysium internum. **Technique:** Zenker's fluid. Celloidin. Picric acid — acid fuchsin.

Fig. 3. A Section from the **Human Cerebral Cortex** Cut Perpendicularly to the Surface of the Central Convolution. × **70.** Only the pyramidal cells and the polymorphic cells are represented (black). Note the increasing size of the pyramidal cells toward their bases; three principal dendrites proceed from each while the axone runs downward from the base of the pyramid. **Technique:** Golgi's silver impregnation.

Fig. 4. Part of a Section of **Human Cerebral Cortex** Cut Perpendicularly to the Surface. × **180.** Under the method of staining here used the cells present a much more natural appearance than under the impregnation process of *Fig. 3*; practically only the pyramidal cells are visible. The nuclei of the cells are seen and also the neurofibrils although the magnification is not very high. Dendrites of other cells are recognizable and the nuclei of many glia cells. **Technique:** Method of Ramon y Cajal for fibrils.

bd = connective tissue septa between the tendon bundles
bg = blood vessels
bgb = connective tissue bundles of the tendon
mf = muscle fibers
ssb = secondary tendon bundles

te = tendon
1 = molecular layer of the cerebral cortex
2 = layer of pyramidal cells of small and medium size
3 = layer of large pyramidal cells
4 = layer of polymorphic cells

Plate 29. **Cerebral Cortex II. Cerebellar Cortex I.**

Fig. 1. Part of a Section of the Human **Cerebellar Cortex** Cut Perpendicularly to the Vermis. × **38.** Special stain for fibers. One entire folium of the cortex is shown and part of another. Note the internal core of medulla and its radiation into the granular layer (plexus-formation; fibers dark blue, cells and blood vessels deep yellow). **Technique:** Müller's fluid. Mordanting in acetic acid—copper oxide. Weigert's stain for medullary sheaths.

Fig. 2. Part of a Section of the Human **Cerebellar Cortex.** × **70.** Detail of *Fig. 1.* The preparation shows the medulla terminating by radiation into the granular layer, within which layer and around the Purkinje cells the fibers are much interwoven. In addition to the granular cells the large Purkinje cells and their main dendrites stand out distinctly as also do the cells of the stratum cinereum. The latter layer remains quite free from medullated fibers. Medullated fibers dark blue. Cells and blood vessels yellow. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Section Perpendicular to the Human **Cerebral Cortex** (Central Convolution). × **50.** Special stain for fibers. Bundles of medullated fibers radiate from the medulla into the cortex where they gradually subdivide. The superficial and deep tangential fibers are seen in part to cross the radial fibers. The pyramidal cells, especially the larger types, stand out clearly (deep yellow). Medullated nerve fibers dark blue, cells and blood vessels deep yellow. **Technique** as for *Fig. 1.*

bg = blood vessels
ms = medulla
otf = superficial tangential fibers
rf = bundles of radial fibers and inter-radial plexus
stci = stratum cinereum
stga = stratum gangliosum (bodies of the Purkinje cells)
stgr = stratum granulosum
stm = molecular layer
ttf = deep tangential fibers (super-radial plexus)

Tab. 29

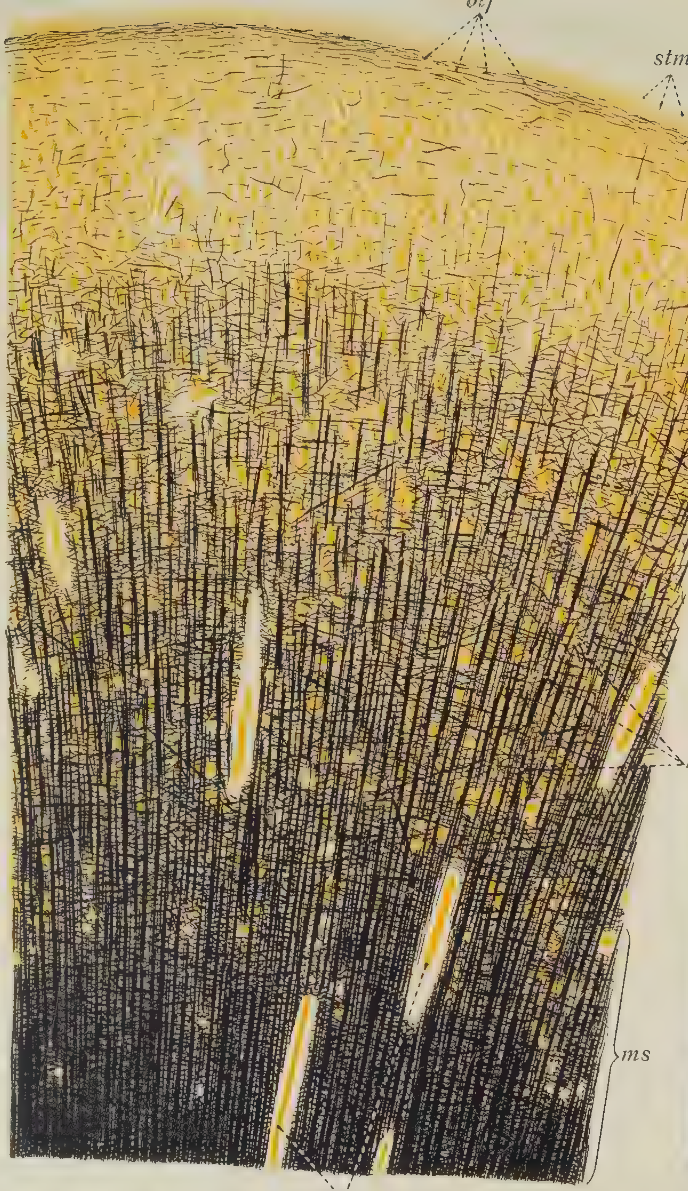

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Fig. 3

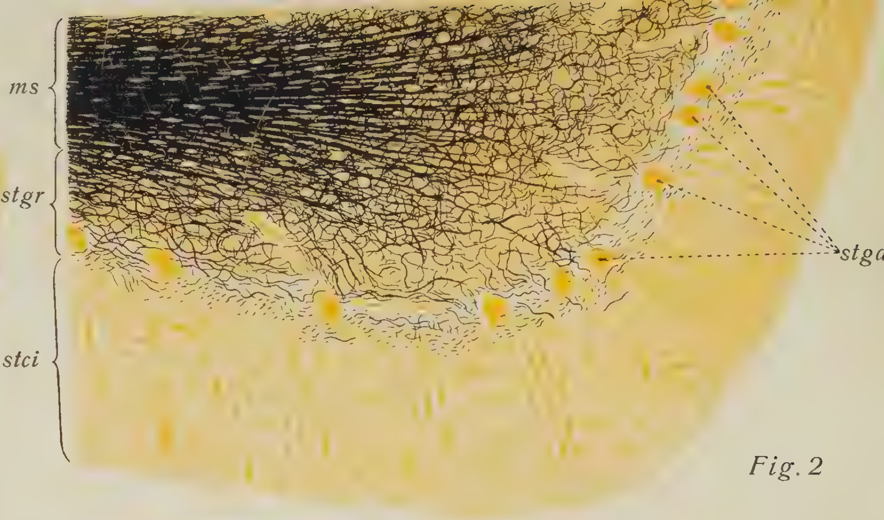
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Fig. 2

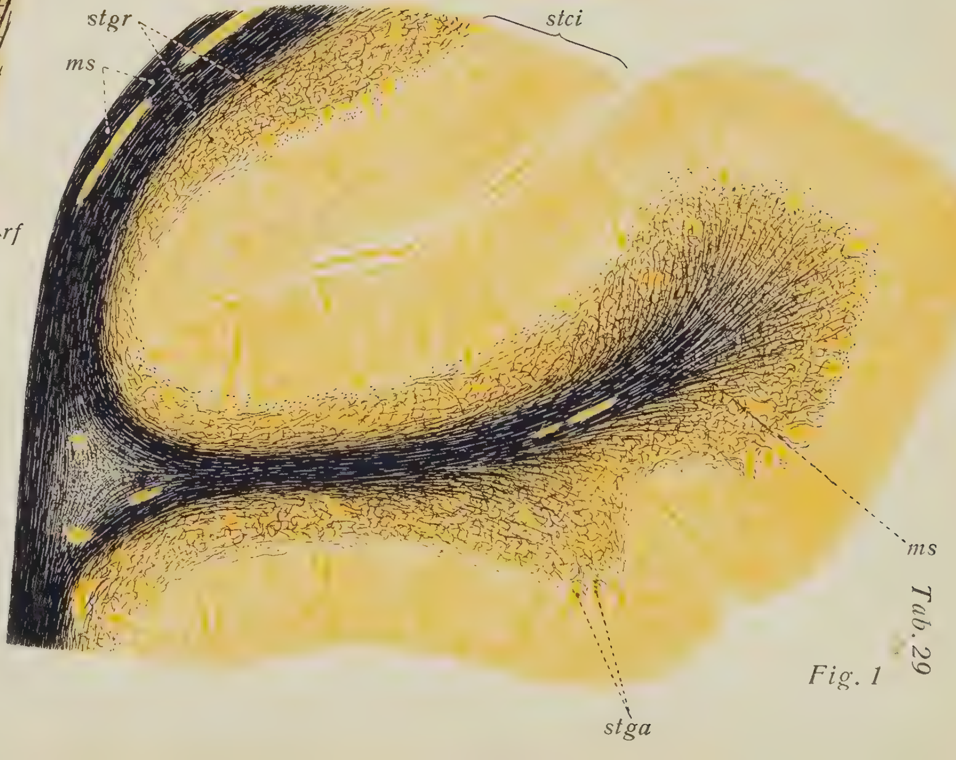
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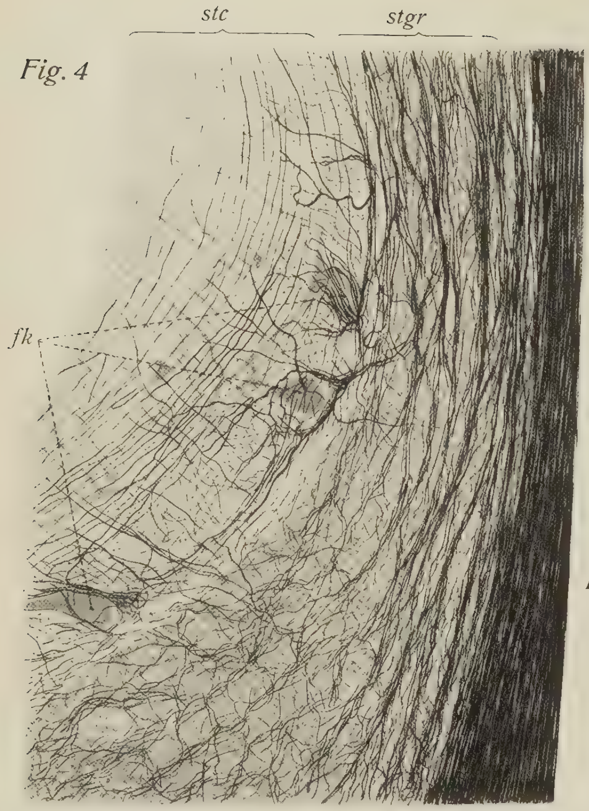
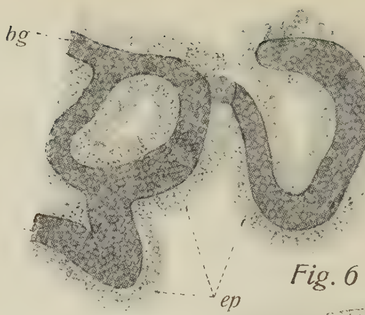
Fig. 1

Tab. 30

Fig. 4





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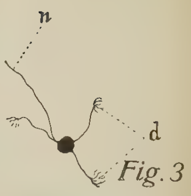

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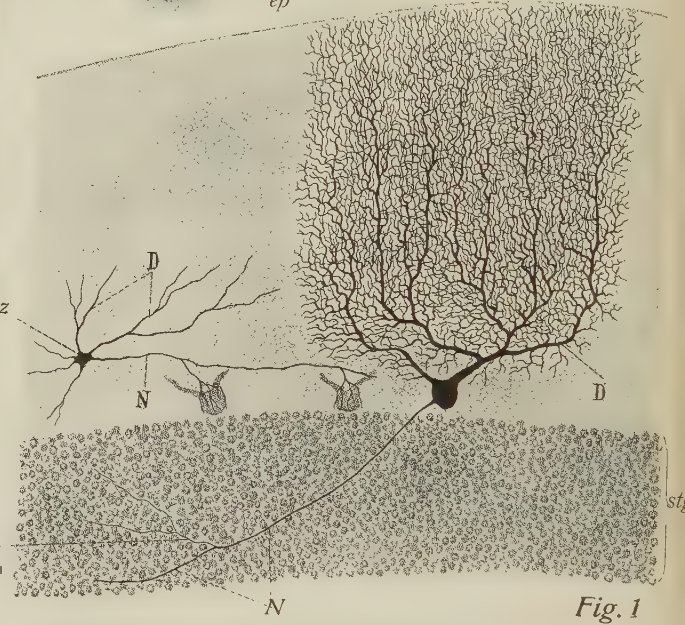
D
Kz
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stg

Fig. 1

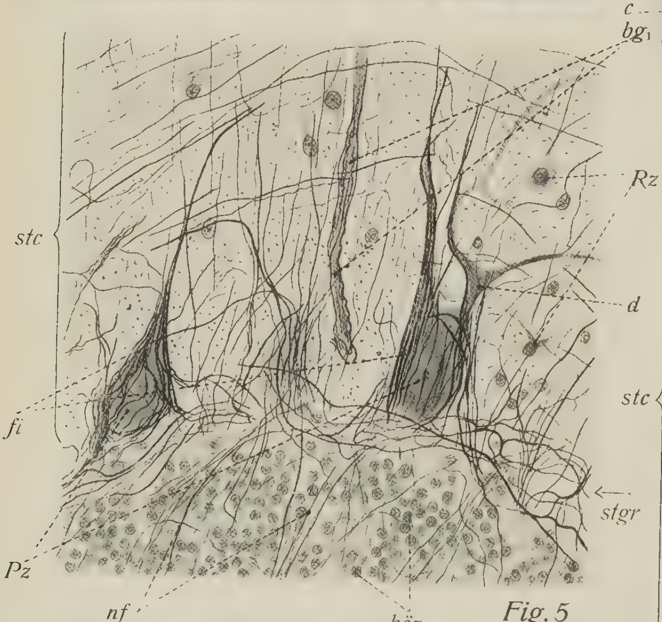
bg₁
Rz
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Fig. 5

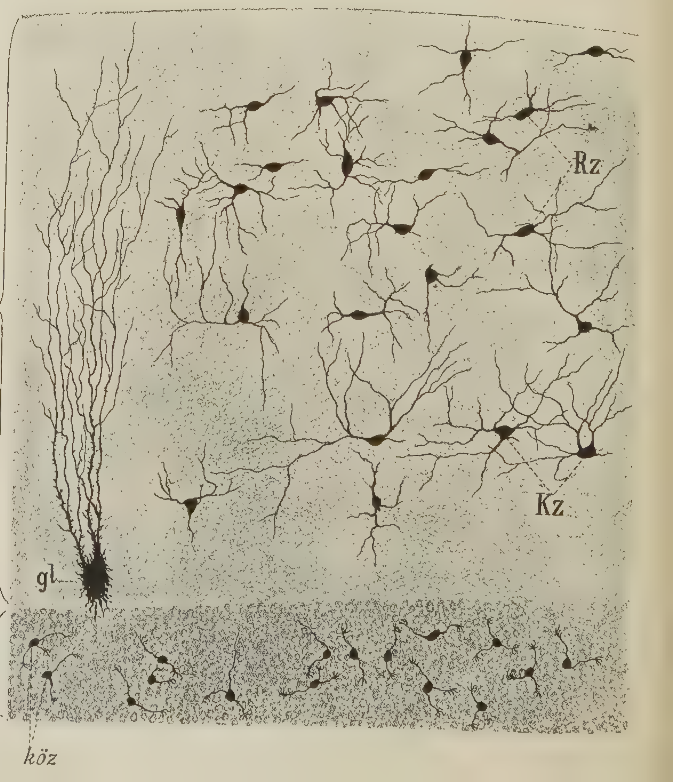
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Fig. 2

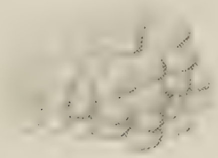

Fig. 7

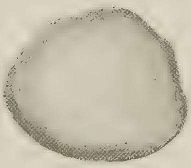

Fig. 8

Plate 30. **Cerebellar Cortex II.**

Fig. 1. Part of a Section (Perpendicular to the Surface) of the Human **Cerebellar Cortex.** Cell picture. × **100.** (Two preparations are combined in the figure.)

The stratum cinereum, stratum gangliosum and most of the stratum granulosum are shown. One Purkinje cell and one basket cell are represented from a silver impregnation, the remaining structures are only suggested. The typical picture of the branching of the dendrites of a Purkinje cell, and of its axone running in the granular layer. On the left is a basket cell the axone of which forms „baskets" around the bodies of two Purkinje cells. **Technique:** Potassium bichromate—osmic acid. Golgi's silver nitrate method.

Fig. 2. Human **Cerebellar Cortex.** × **140.**

Similar and supplementary to Fig. 1, picturing the small cells of the stratum cinereum, glia cells and small granular cells. On the left a so-called Bergmann's glia cell; above and on the right small cortical cells such as are scattered sparingly in the stratum cinereum; on the right but deeper in the layer are basket cells, the baskets of which are not shown. Of the small granular cells so closely crowded together only isolated cells have been blackened by the impregnation; their axones are not shown. **Technique** as for *Fig. 1.*

Fig. 3. **Small Granular Cell** from the Human Cerebellar Cortex. × **330.**

In addition to the three fine dendrites the axone, which runs perpendicularly into the stratum cinereum, is visible. **Technique** as for *Figs. 1 and 2.*

Fig. 4. Human **Cerebellar Cortex. Fiber Picture.** × **220.**

There is seen the entire thickness of the cerebellar cortex and a part of the medulla lying beneath; the latter is very dark and lies at the right while the surface of the cortex is at the left. The cells appear in grey and contrast sharply with the very dark fibers (cf. Pl. 14, *Fig. 6*; Pl. 29, *Fig. 3*). Extremely fine fibers run parallel to the surface in the stratum cinereum; some of them are cut across and appear as points, others are cut lengthwise. These are the axones of basket cells and are less numerous toward the surface; in addition to these other fibers are seen to rise perpendicularly out of the plexus of the stratum granulosum. The fiber baskets around the bodies of the Purkinje cells are visible. In the stratum granulosum are fine fibers which form a plexus around groups of the granular cells; this plexus passes gradually into the medulla which consists exclusively of nerve fibers. **Technique:** The caustic soda—silver method of O. Schultze.

Fig. 5. From the Human Cerebellar Cortex. **Cell and Fiber Picture.** × **220.**

The stratum gangliosum is seen with the adjacent parts of the stratum granulosum and stratum cinereum. The bodies of two Purkinje cells with their chief dendrites are clearly recognized; a third cell is just touched by the section. Neurofibrils are seen in the cell bodies and chief dendrites and as fiber baskets around the bodies of the cells. Nuclei of the small granular and small cortical cells are visible, also fibers from the plexus of the stratum granulosum and transverse and longitudinal sections of fibers in the stratum cinereum (*Fig. 4*). **Technique** as for *Fig. 4.*

Fig. 6. A Portion of the **Venous Plexus** from the Human Lateral Ventricle. × **250.**

Examined in the fresh condition. The capillary loops are seen to be well filled with blood, the red corpuscles of which are visible. A simple cubical epithelium, the ependymal epithelium, is closely applied to the loops; within its cells are yellow pigment granules (lipofuscin). The scanty connective tissue within which the capillaries are embedded is practically not recognizable. **Technique:** Fresh preparation in physiological salt solution.

Fig. 7. **Brain Sand** from the Venous Plexus of the Human Lateral Ventricle. × **40.**

A concretion of amorphous calcareous particles of rounded form. **Technique** as for *Fig. 6.*

Fig. 8. A Particle of Brain Sand. × **180.**

The concentric layers are clearly visible. **Technique** as for *Fig. 6.*

bg = capillaries of the venous plexus
bg_1 = capillary of the cerebellar cortex with reticulum fibers
c = collaterals of the axone
D(*d*) = dendrites
ep = epithelium of the venous plexus
fi = neurofibrils of the Purkinje cells
fk = fiber baskets of the Purkinje cells
gl = Bergmann's glia cell of the cerebellar cortex
Kz = basket cells
köz = granular cells
N(*n*) = axone
nf = nerve fibers
Pz = Purkinje cells
Rz = small cortical cells
stc = stratum cinereum
stgr = stratum granulosum

Plate 31. **Cerebral and Cerebellar Cortices III, Hypophysis, Epiphysis.**

Fig. 1. From a Section Perpendicular to the Human **Cerebral Cortex.** × **40.** General view of the cerebral cortex. The cells are stained red, the fibers are quite pale and scarcely visible. The preparation shows the essential distribution of the pyramidal cells. **Technique:** Müller's fluid. Staining in toto with sodium carminate. Celloidin.

Fig. 2. Part of a Section Perpendicular to the **Cerebellar Cortex.** × **20.** General view of the structure of the cerebellar cortex. The medulla is quite pale; the granular layer with its densely crowded nuclei is much darker; the stratum cinereum is again rather pale. In spite of the low magnification the Purkinje cells of the stratum gangliosum and their main dendrites stand out clearly. Differences are to be recognized between the closeness of their grouping at the apices and at the bases of the folia. **Technique** as for *Fig. 1.*

Fig. 3. A small Portion of a Very Thin Section of the Human **Cerebellar Cortex.** × **150.** The figure shows the stratum gangliosum and the edge of the granular layer. The Purkinje cells are shown and also the so-called eosin bodies in the spaces between the groups of granular cells. **Technique:** Müller's fluid. Paraffine. Haematoxylin-eosin.

Fig. 4. Part of a Sagittal Section of the Human **Hypophysis.** × **48.** There is seen the boundary between the epithelial part of the organ, above, and the nervous part, below. The former consists chiefly of solid strands of cells; at its margin next to the nervous portion there appear cavities and at times vesicles filled with colloid. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 5. Part of a Section through the Human **Epiphysis** (Pineal Body). × **90.** General picture of the epiphysis. Masses of epithelial cells are seen which in part form anastomosing cords separated by relatively large amounts of connective tissue. **Technique** as for *Fig. 4.*

bdg = connective tissue
bg = blood vessels
cf = solid cords of cells
co = colloid
cstga = Purkinje cells (of the stratum gangliosum)
epf = epithelial masses of the epiphysis
eos = eosin bodies
fo = glandular follicles
grp = large pyramidal cells
klgr = groups of small granular cells
klp = small pyramidal cells
la = anterior, epithelial lobe of the hypophysis
lp = posterior, nervous lobe of the hypophysis
pm = pia mater
pol = layer of polymorphous cells
sc = cortex
sm = medulla
stc = stratum cinereum
stga = stratum gangliosum
stgr = stratum granulosum
vc = capillaries
1 = molecular layer

Tab. 31

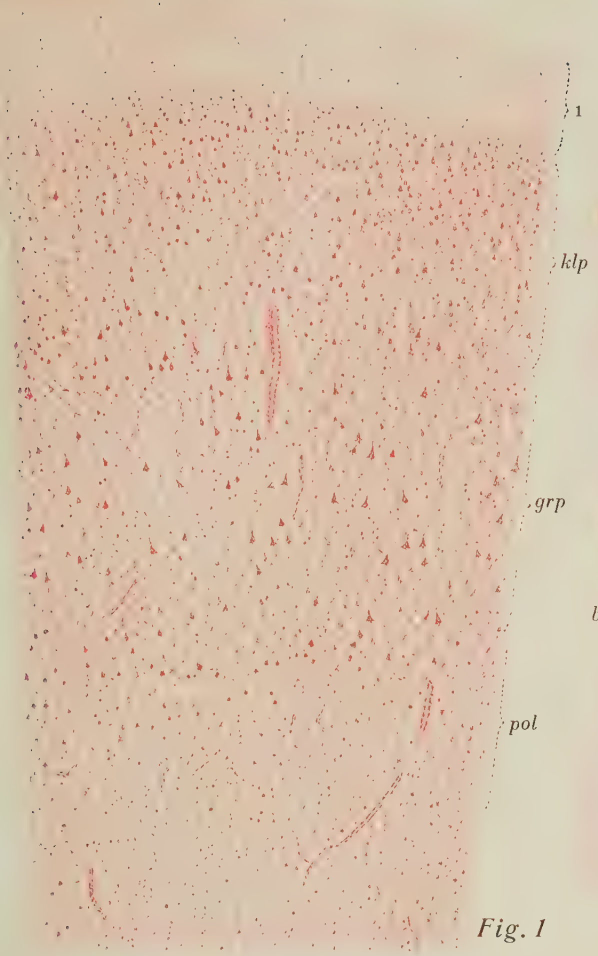
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Fig. 1

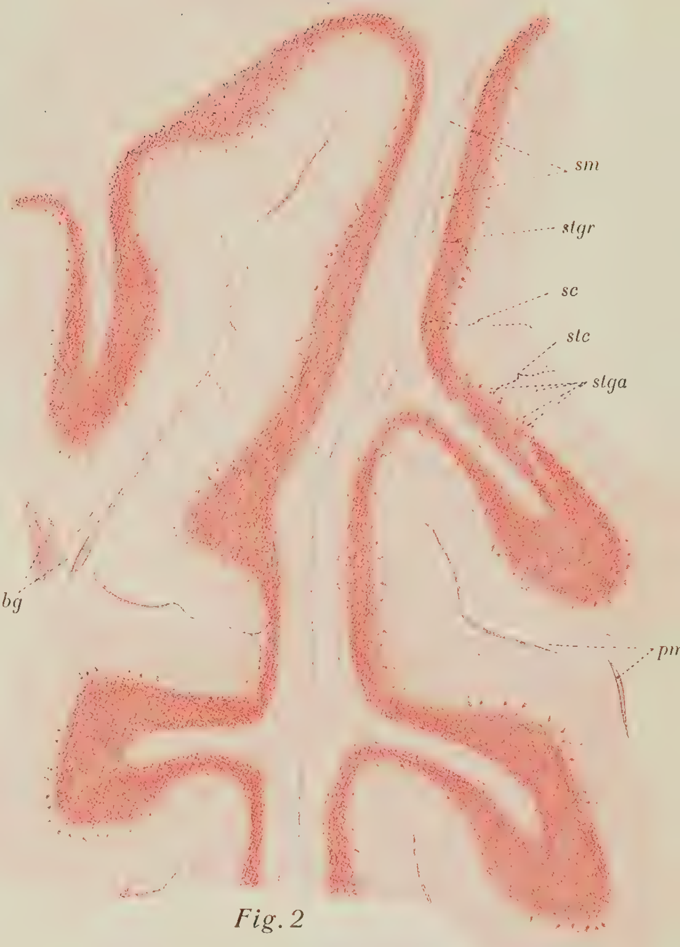
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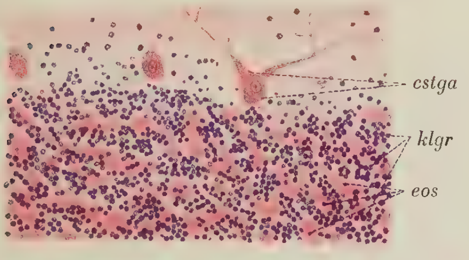
Fig. 2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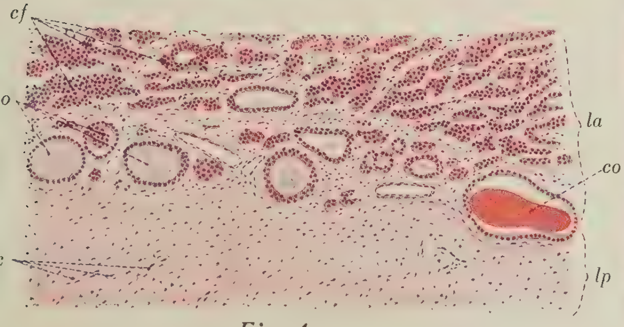
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Fig. 4

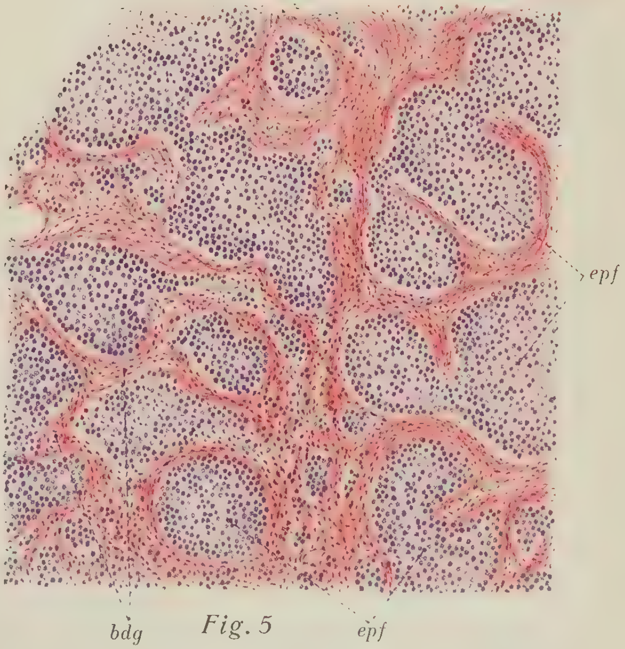

Fig. 5

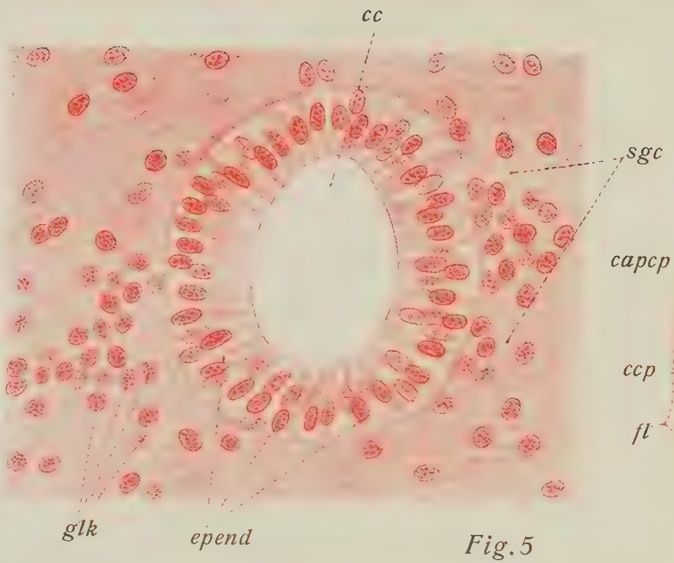
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Fig. 5

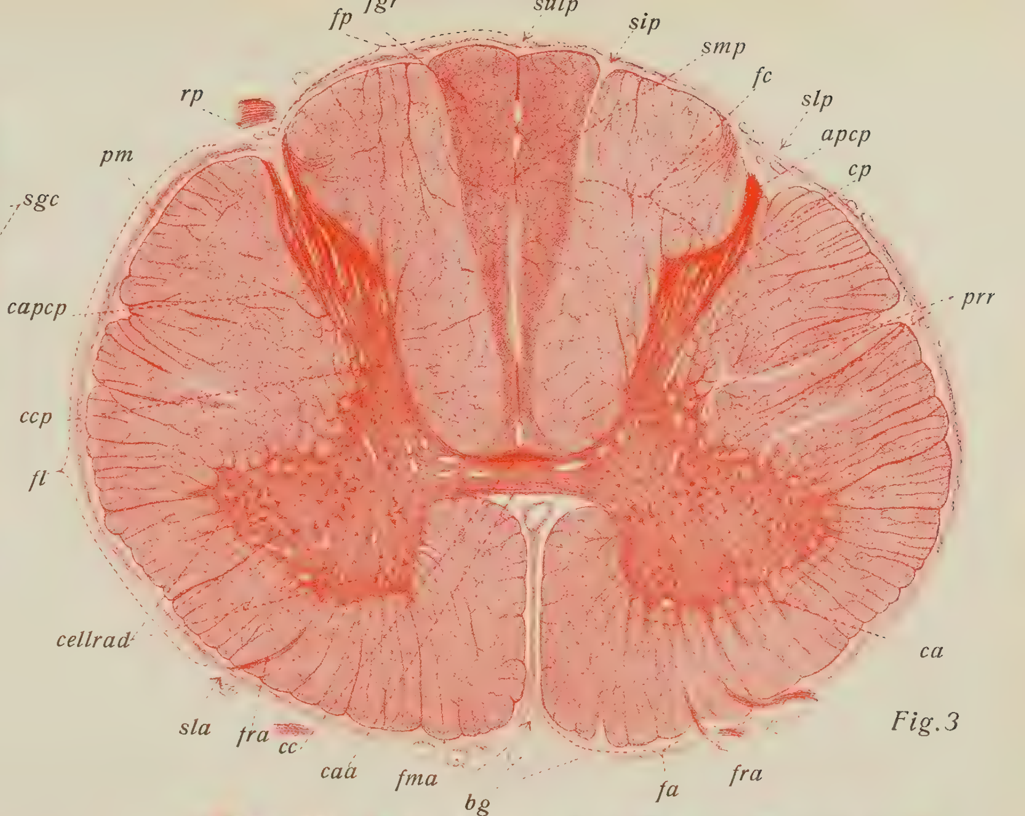
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Fig. 3

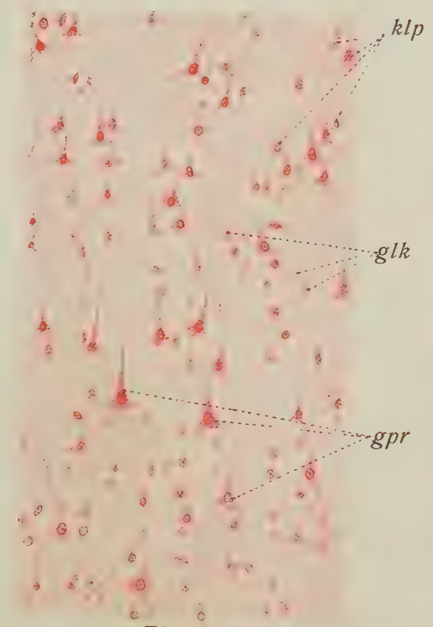

Fig. 1

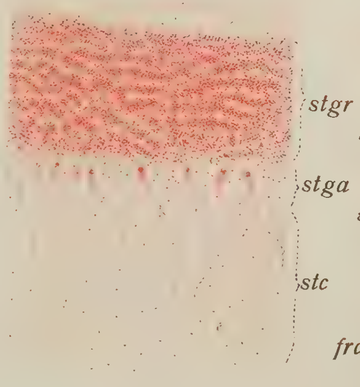
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Fig. 2

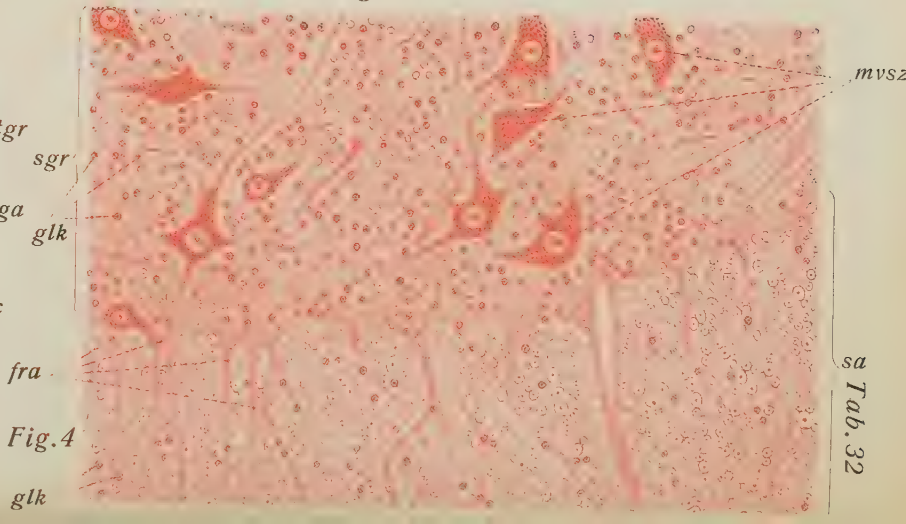
mvsz
sgr
glk
fra
glk
sa

Fig. 4

Plate 32. **Cerebral and Cerebellar Cortices IV, Spinal Cord I.**

Fig. 1. Part of a Section Perpendicular to the Human **Cerebral Cortex.** × **125.** There is seen the region of the large pyramidal cells between which are scattered medium and small pyramidal cells. The main dendrites are distinctly visible and also in a few cases the axones of the cells. Between the pyramidal cells are the nuclei of many glia cells. **Technique:** Müller's fluid. Staining in toto with sodium carminate. Celloidin.

Fig. 2. Detail of **Cerebellar Cortex.** × **50.** A small part of the preparation pictured in *Fig. 2*, Pl. 31, somewhat more highly magnified. The nuclei of the cells of the stratum cinereum are seen, the Purkinje cells are very distinct as is also the arrangement of the granular cells in groups. **Technique** as for *Fig. 1.*

Fig. 3. Transverse Section of the **Spinal Cord,** Cervical Enlargement (Human, aet. 22. Execution). × **8.** General topographical picture of the spinal cord and its pia mater. The distribution of the white matter (light red) and of the grey matter (dark red) is seen, also the chief funiculi of the white matter and the subdivision of the posterior funiculus. Bundles of the anterior root fibers are leaving and the compact fiber masses of the posterior roots are entering the cord. The central canal is obliterated. **Technique** as for *Fig. 1.*

Fig. 4. Part of the Same Section of **Spinal Cord** as Shown in *Fig. 3.* × **130.** The boundary between the anterior horn and the white substance is represented. The cross sections of the fibers of the white matter are seen to have varying diameters; also the fibers of the anterior roots and scattered nuclei of glia cells are seen. In the grey matter are the large motor cells of the anterior horn showing Nissl granules; the nuclei of glia cells are numerous. Under this method of staining the interlacement of fibers in the grey matter is indistinct. **Technique** as for *Fig. 1.*

Fig. 5. **The Central Canal of the Spinal Cord.** × **400.** From a young person. The ependymal epithelium is seen, under this method of staining, to give the impression of an ordinary columnar epithelium; its glial nature is not shown at all in the figure. The lumen of the canal is quite open (juvenile). In the neighborhood are nuclei of astrocytes of the interlacing glia which forms the substantia gelatinosa centralis. **Technique** as for *Fig. 1.*

apcp = apex of the posterior horn
bg = blood vessels
ca = anterior horn
caa = anterior white commissure
cc = central canal
capcp = caput of the posterior horn
ccp = cervix of the posterior horn
cp = posterior horn
cellrad = cellulae radiculares
epend = ependymal epithelium
fa = funiculus anterior
fc = funiculus cuneatus
fgr = funiculus gracilis
fl = funiculus lateralis
fma = anterior median fissure
fp = funiculus posterior
fra = fibers of the anterior root
glk = nuclei of neuroglia
gpr = large pyramidal cells
klp = small pyramidal cells
mvsz = motor cells of the anterior horn
pm = pia mater
prr = formatio reticularis
rp = posterior root
sa = substantia alba
sgc = substantia gelatinosa ventralis
sgr = substantia grisea
sip = sulcus intermedius posterior
sla = sulcus lateralis anterior
slp = sulcus lateralis posterior
smp = posterior median septum
stc = stratum cinereum
stga = stratum gangliosum
stgr = stratum granulosum
sulp = posterior median sulcus

Plate 33. **Spinal Cord II.**

Fig. 1. **Transverse Section of Human Spinal Cord,** Lumbar Enlargement. × **15.** General view of the structure of the spinal cord. Fiber picture. The medullated fibers are stained dark bluish-violet. The nuclei of the cells of the cord and of the pia mater are red. The connective tissue of the pia mater and the cytoplasm of the nerve cells are pale red. The distinction is clearly expressed between the white matter consisting almost entirely of medullated fibers running longitudinally, and the grey matter with its wealth of nerve and glia cells. Nevertheless numerous medullated fibers interwoven in the grey matter are visible even under this enlargement; especially do those coming from the region of the posterior funiculus stand out clearly. They traverse the posterior horn and in part (in the left of the picture) may be followed into the anterior horn. The difference in behavior of the bundles of anterior root fibers arising from the anterior horn, and of those entering into the cord from the posterior root is clearly recognizable. Note the blood vessels of the pia mater and their entrance into the cord. The central canal has been obliterated. **Technique:** Müller's fluid. Celloidin. Weigert-Pal staining for fibers.

Fig. 2. **Part of a Transverse Section of the Human Spinal Cord** Similar to *Fig. 1.* × **75.** The figure shows essentially the ventral portion of an anterior horn as well as the adjacent areas of the white matter of the lateral and anterior funiculi. In the region of the white matter there are to be recognized the medullated fibers of the funiculus cut across, and running through them the fibers of the anterior root cut longitudinally. In the grey matter the large cells of the anterior root are clearly seen standing out like pale red islands in the surrounding network of dark blue fibers. Under the enlargement employed a clear picture of the number of medullated fibers present in the grey matter is obtained since each individual fiber shows distinctly. The nuclei of the glia cells are seen as red points, sparingly between the fiber masses of the white matter and abundantly in the grey matter. **Technique** as for *Fig. 1.*

apcp = apex of the posterior horn
bg = blood vessel of the pia mater entering the grey matter
caa = anterior white commissure
ca = anterior horn
cc = location of obliterated central canal
cellrad = cellulae radiculares
cole = collaterals } from the posterior
collr = reflex collaterals } funiculus
cop = posterior commissure
cp = posterior horn
fa = funiculus anterior
fl = funiculus lateralis
fma = anterior median fissure
fp = funiculus posterior
fra = fila radicularia anteriora
fret = formatio reticularis
mnf = medullated nerve fibres of the grey matter
nd = nucleus dorsalis
rp = posterior root
rz = zone of Lissauer
sa = white matter
sgp = substantia gelatinosa posterior
sgr = grey matter
sp = posterior median sulcus

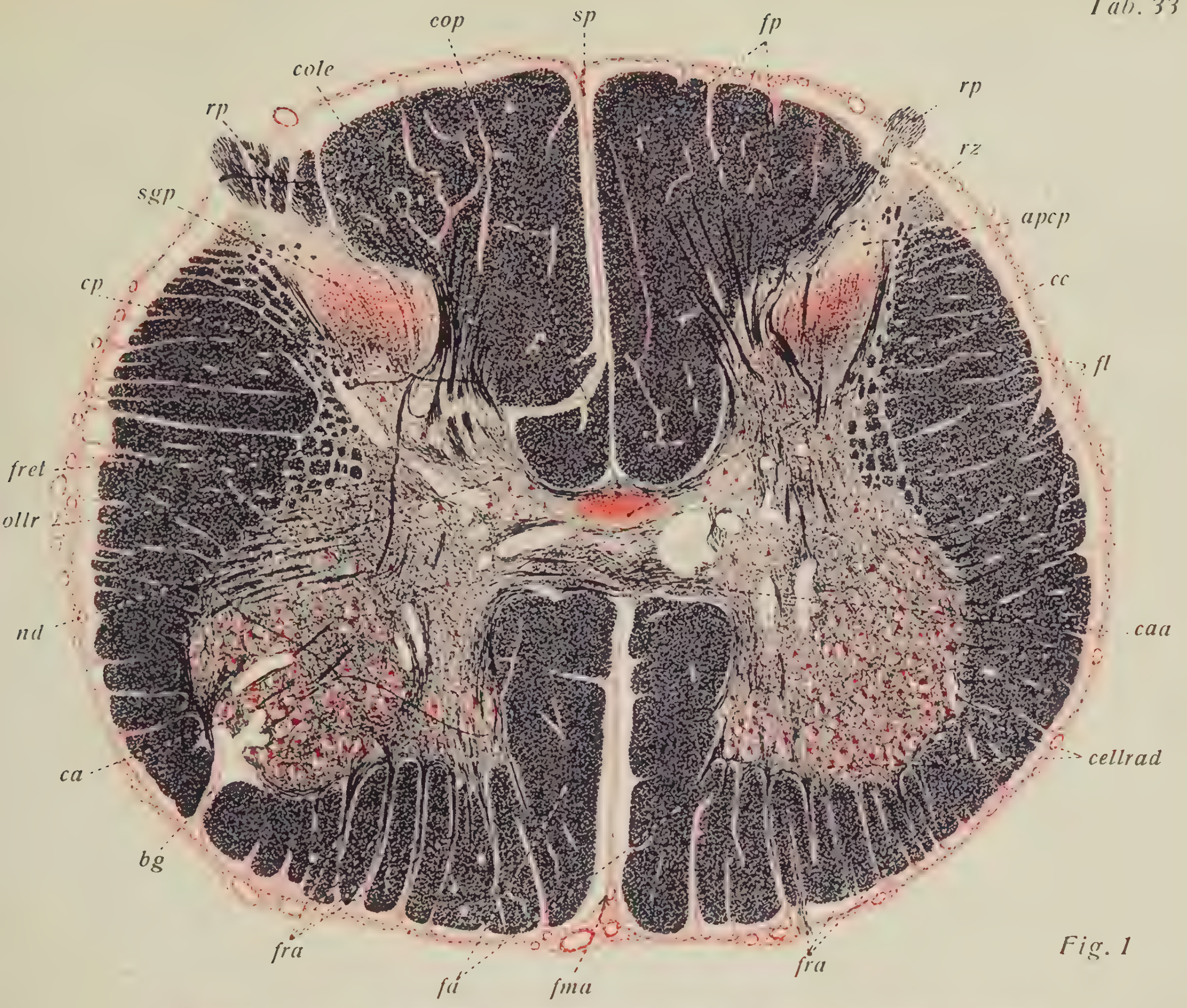
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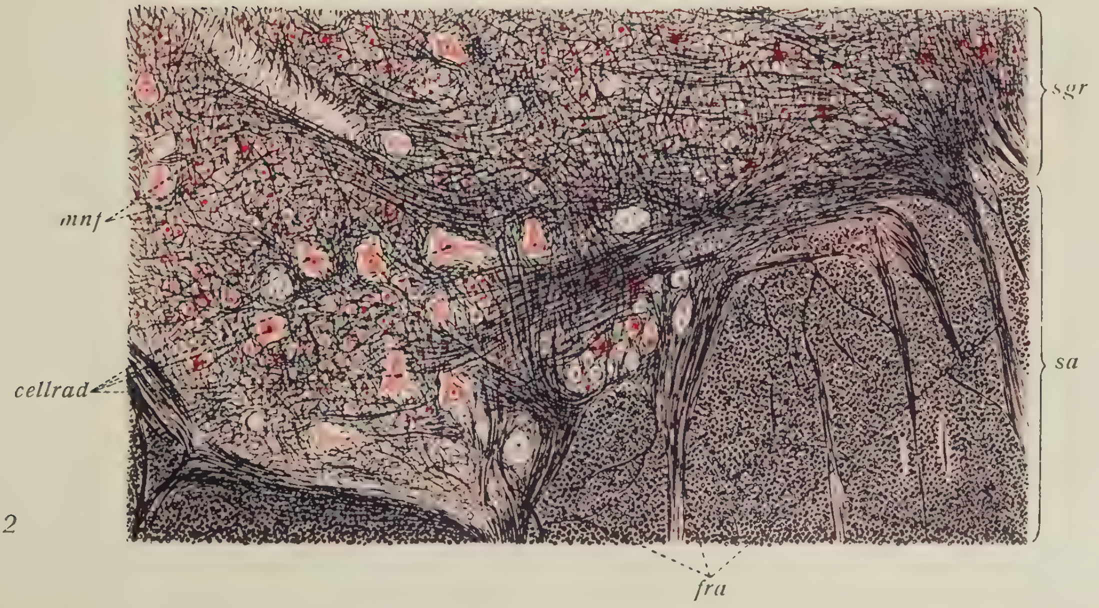
Fig. 1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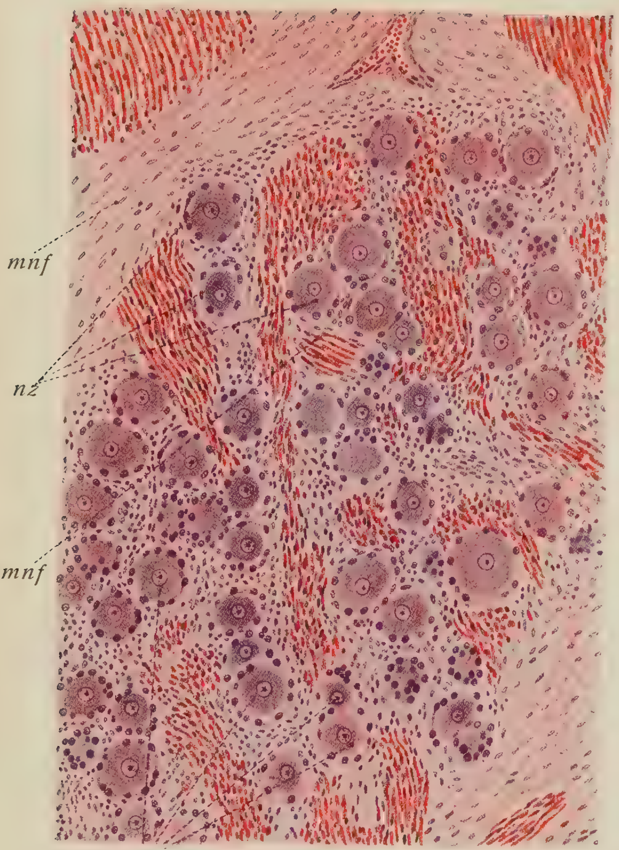
ig. 2

Tab. 34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mnf
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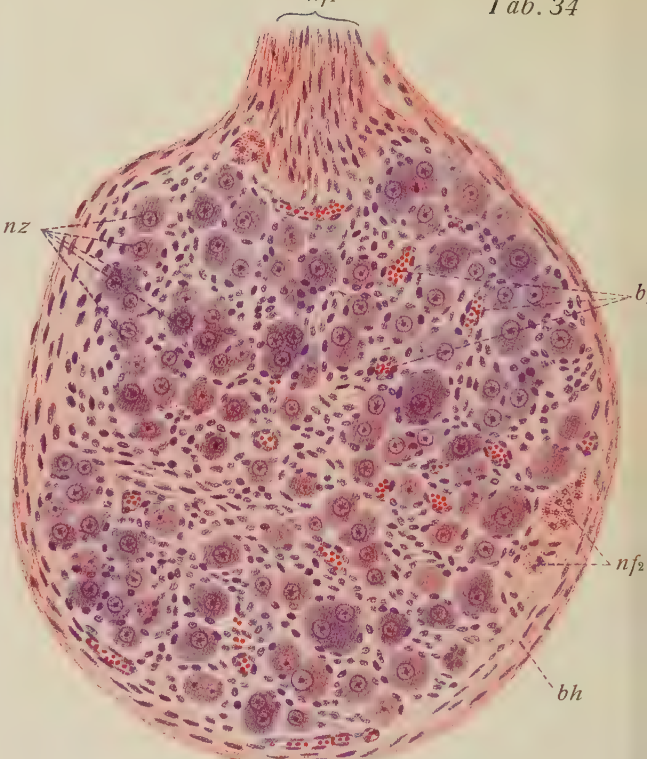
Fig. 2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nf2
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Fig. 4

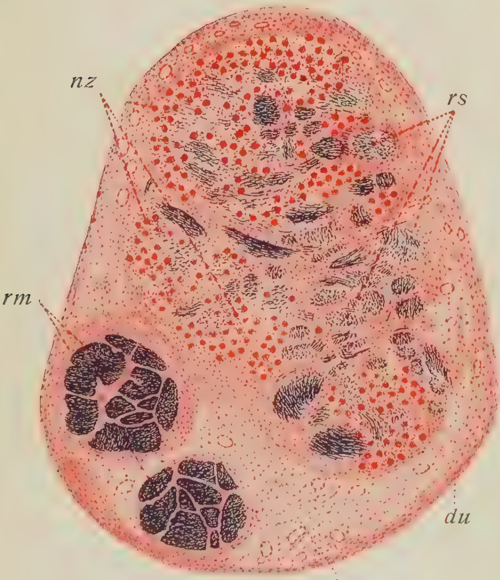
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Fig. 1

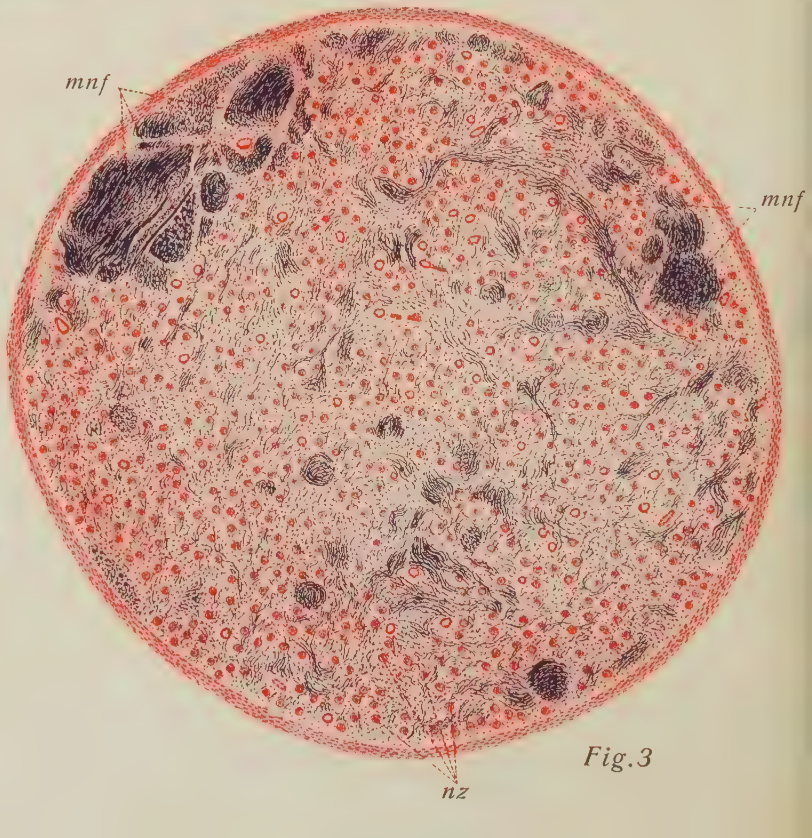

Fig. 3

Plate 34. **Peripheral Ganglia.**

Fig. 1. Transverse Section through a **Human Spinal Ganglion.** × **15.** General view. Surrounded by a heavy wall of connective tissue (process of the dura mater) the motor root appears in the form of two compact strands of nerve fibers. Nearby in the ganglion proper are the subdivisions of the sensory root, the medullated fibers (dark blue) of which appear singly or in small groups between the spherical nerve cells (red spots) from which they arise. **Technique:** Müller's fluid. Celloidin. Weigert-Pal staining for medullary sheaths. Alum carmine.

Fig. 2. Part of a Section of a **Spinal Ganglion.** (Human, aet. 28. Execution.) × **140.** The large, spherical, spinal ganglion cells with their surrounding nucleated capsules and spherical resting nuclei stand out clearly in spite of the relatively low enlargement; their protoplasm appears violet by contrast with the vivid red of the eosin—staining in the medullated nerve fibers visible everywhere in the preparation. Note the varying size of the cells and intensity of stain in their protoplasm. Here and there is a cell which contains fine pigment granules (cf. Pl. 16). **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 3. Transverse Section of the **Superior Cervical Sympathetic Ganglion** (Human, aet. 22. Execution). × **28.** General view. Within a distinct connective-tissue capsule lie numerous sympathetic nerve cells appearing as round red spots; while between them lie bundles of fine non-medullated, sympathetic nerve fibers but slightly noticeable under this magnification. Fine medullated fibers are scattered through almost the entire preparation; in a few places they are grouped into larger bundles. In part these are cerebrospinal nerve fibers running within the sympathetic system. **Technique** as for *Fig. 1.*

Fig. 4. A Section through a Small **Sympathetic Ganglion** (Source as for *Fig. 3*, Region of the Seminal Vesicle). × **280.** A small trunk of non-medullated nerve fibers is seen entering a tiny ganglion surrounded by a connective-tissue capsule. The nerve cells are apparently quite spherical and in part are multinuclear; their nucleated capsules are seen but not their processes. The cells vary quite widely in size. In addition to blood vessels there are seen between the cells non-medullated nerve fibers, cut across or longitudinally; and arranged singly or in bundles. Note the small size of the sympathetic cells as compared with the spinal ganglion cells (*Fig. 2* × **140**, *Fig. 4* × **280**). **Technique:** Paraffine, otherwise as for *Fig. 2.*

bg = blood vessels
bh = connective-tissue capsule
du = dura mater
fe = adipose tissue
mnf = medullated nerve fibers
nf = non-medullated nerve fibers
nf_1 = non-medullated nerve fibers cut longitudinally
nf_2 = non-medullated nerve fibers cut transversely
nz = nerve cells
rm = anterior (motor) root
rs = posterior (sensory) root

Plate 35. **Peripheral Nerves.**

Fig. 1. Transverse Section of a **Peripheral Nerve** (Human, aet. 22. Execution). × **35.** General view of a peripheral nerve trunk. The fibers are medullated, run longitudinally in the nerve, and are separated into bundles (fasciculi) of different sizes each surrounded by a stout perineural sheath. A less dense connective-tissue wrapping, the epineurium, bearing blood vessels holds all the fasciculi together; while from the perineurium tapering strands of connective tissue, the so-called endoneurium (see *Figs. 2 and 3*), run into the interior of the fasciculi. **Technique:** Müller's fluid. Celloidin. Picric acid–acid fuchsin.

Fig. 2. Part of a Transverse Section of a **Peripheral Nerve.** × **140.** There are seen parts of small, medium, and large fasciculi and two small fasciculi entire. The dense perineural sheath is distinct from the epineurium with its blood vessels. Processes from the perineurium enter the fasciculi and constitute the endoneurium, the finest branches of which are not rendered distinct by this enlargement. The fasciculi show numerous cross sections of medullated nerve fibers which differ widely in diameter. **Technique** as for *Fig. 1.*

Fig. 3. A Small Portion of a **Transverse Section of a Nerve.** × **600.** The borders of three fasciculi with adjacent parts of their heavy perineural sheaths are shown. One of the fasciculi is represented by only three nerve fibers; while larger areas of the other two fasciculi are included in the figure. In the middle of the cross sections of the nerve fibers are seen the much shrunken axis cylinders (red) around each of which is the greatly swollen medullary sheath (yellow) with peculiar concentric rings; quite externally the sheath of Schwann (neurolemma) appears as a fine red ring. Note the extreme difference in the thickness of the various nerve fibers, particularly as regards the medullary sheath. The nerve fibers are embedded in the endoneural connective tissue (red) the fiber bundles of which form sheathlike wrappings around the individual fibers (endoneural sheaths). **Technique:** very thin paraffine section, otherwise as for *Figs. 1 and 2.*

bg = blood vessels
ensch = endoneural sheaths
epin = epineurium
fe = adipose tissue
fn = fasciculi
mn_1 = transverse sections of thick medullated nerve fibers
mn_2 = transverse sections of thin medullated nerve fibers
pn = perineurium

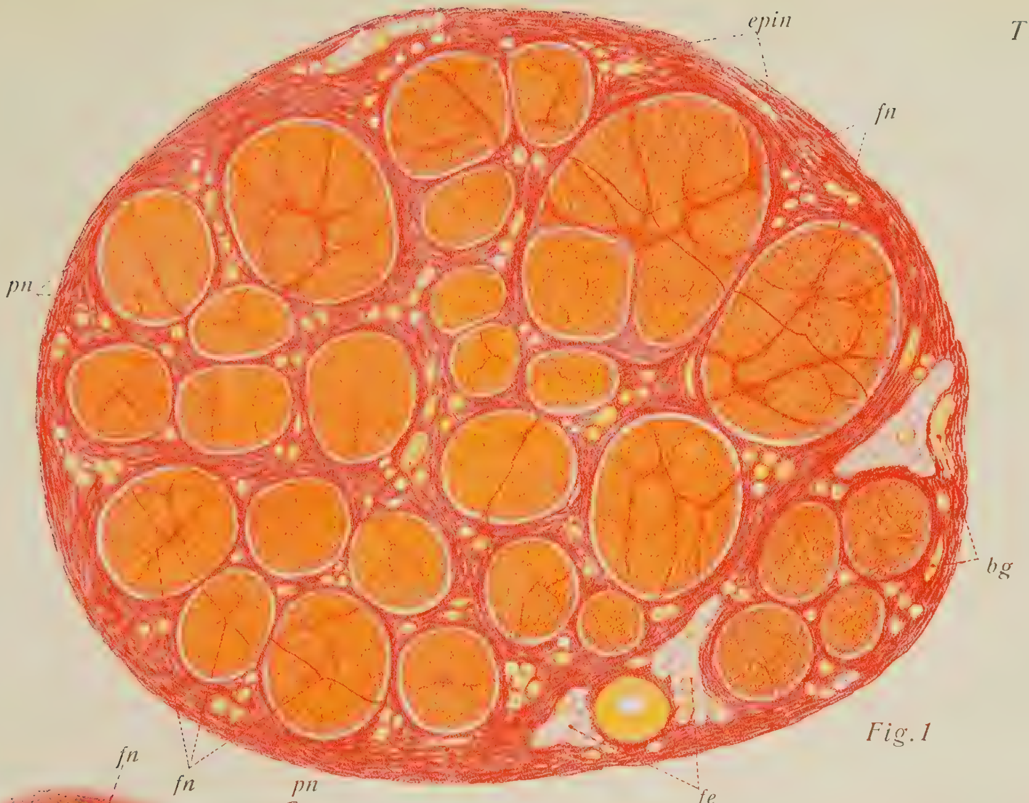
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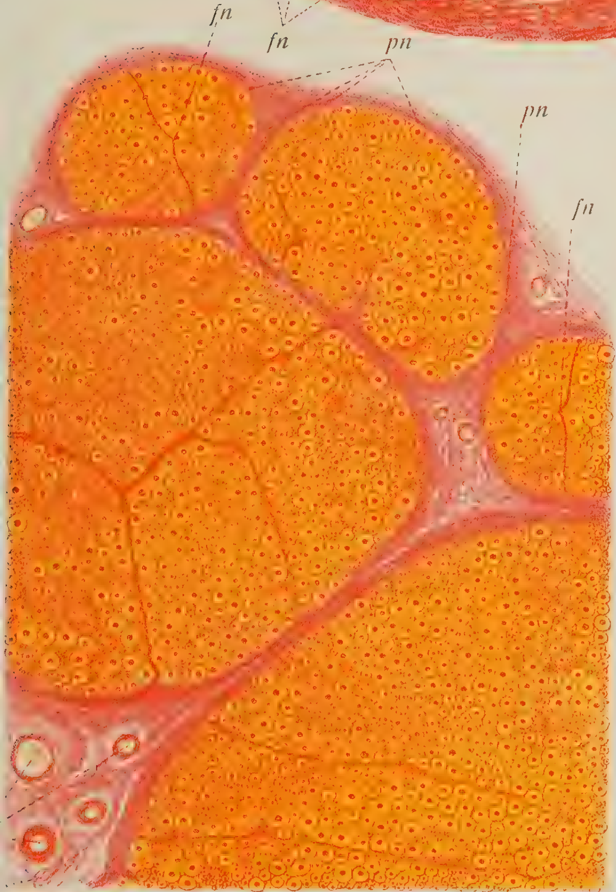
Fig.1



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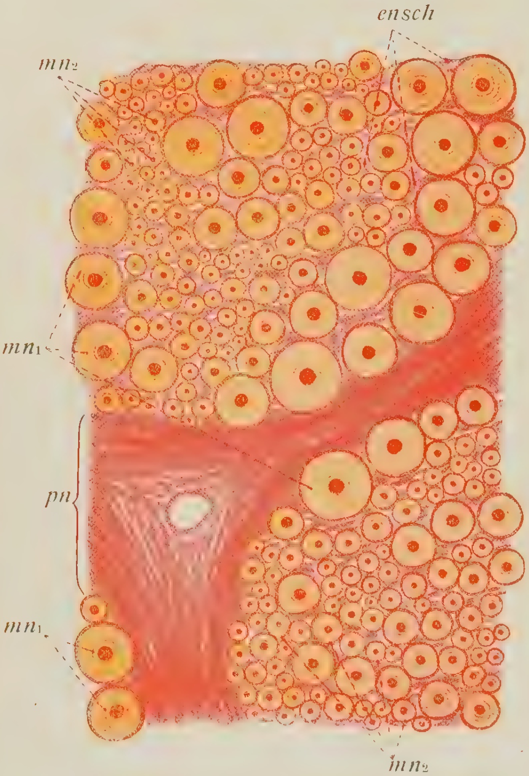
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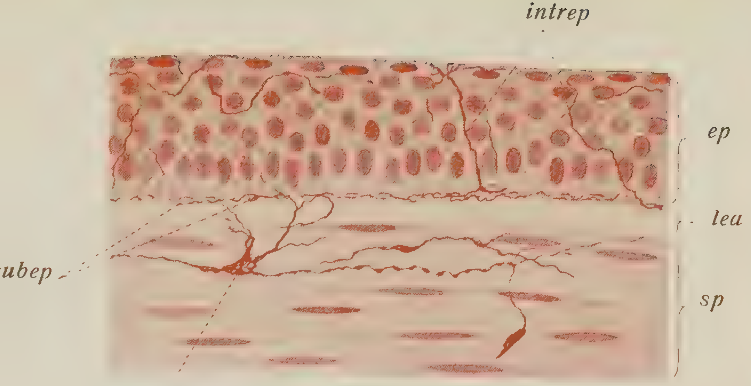
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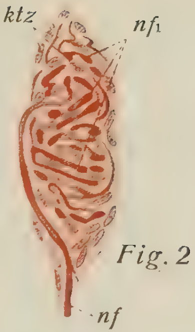
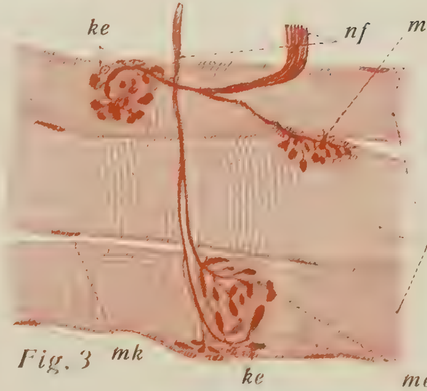


Fig. 2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mk
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me

Fig. 3

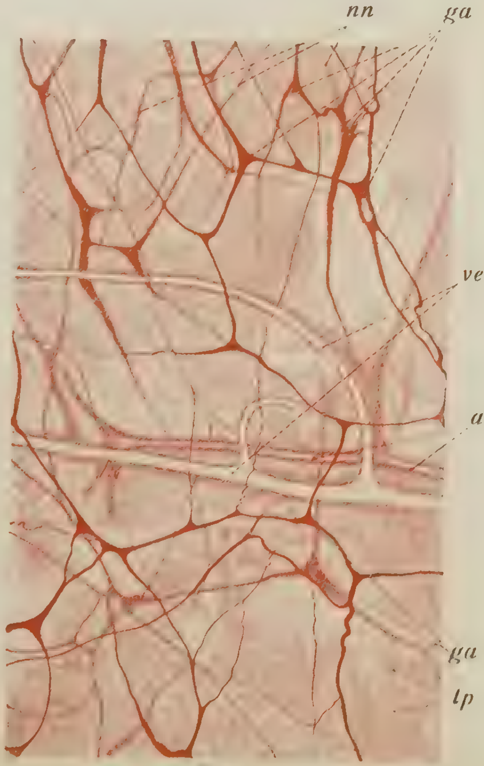
nn
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Fig. 4

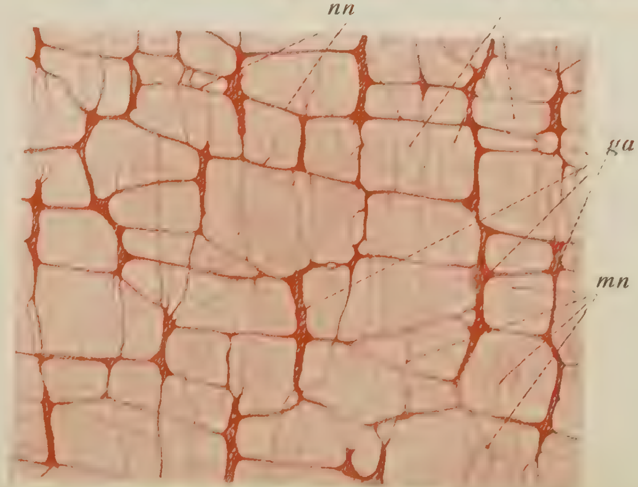

Fig. 5

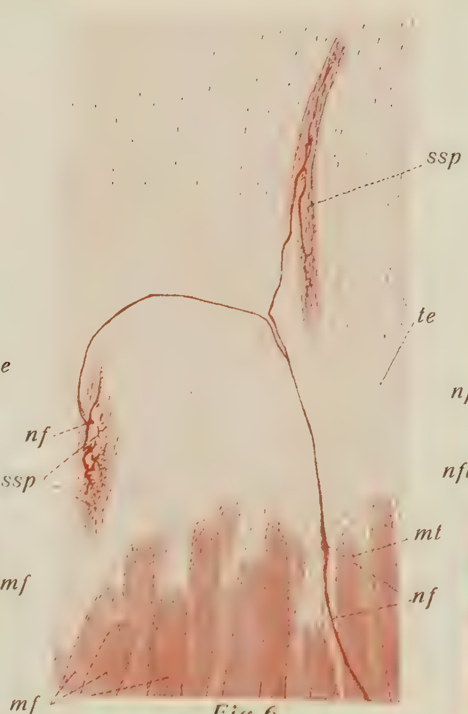
ssp
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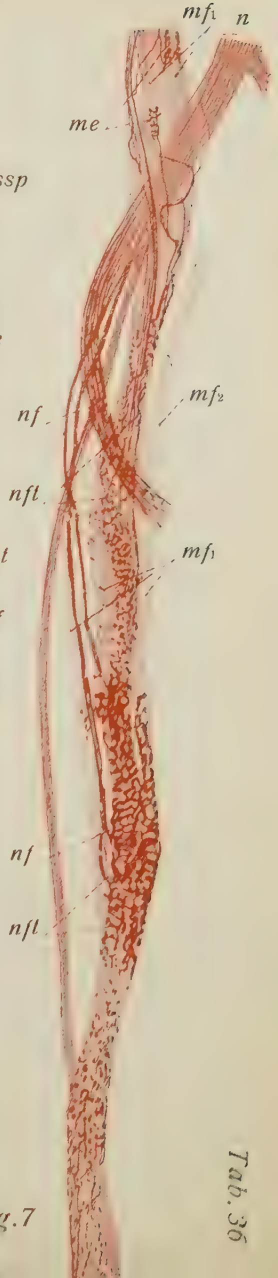
Fig. 6


mf1
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mf2
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Fig. 7

Plate 36. **Nerve Endings I.**

Fig. 1. Part of a Section Perpendicular to the Cornea (Rabbit); **Free Intra-epithelial Endings.** × **375.** The nerves (stained deeply) spread out in the epithelium beneath which they form a plexus. **Technique:** Gold chloride-formic acid. Celloidin.

Fig. 2. **Tactile Corpuscle** from a Papilla of the Human Corium. × **425.** (Section perpendicular to the skin of a finger.) The nerve fiber is seen to enter the corpuscle and spread out between the tactile cells, the nuclei of which are distinctly stained. **Technique** as for *Fig. 1.*

Fig. 3. **Motor End Plates** from a Human Pectoral Muscle. × **370.** Three striated muscle fibers are seen and four end plates, two of which lie close together upon the same fiber; two plates are viewed from the surface, a third one is half turned and the fourth is seen edgewise. The nerve fiber which goes to the two neighboring plates divides shortly before reaching them. The expansions of the nerve fibers within the plates are but incompletely stained. **Technique:** Gold chloride—formic acid. Teased preparation mounted in glycerine jelly.

Fig. 4. **Plexus Submucosus** of the Human Small Intestine. × **90.** Layers of the plexus with ganglia at the knots are seen to be superimposed in different planes; blood vessels of the submucosa are visible and beneath all is the mucous membrane. **Technique:** The intestine was filled with and immersed in dilute (about ½ %) acetic acid for 24 hours. The two muscular layers have been dissected away from the mucous coat so as to leave the plexus attached to the latter. Gold impregnation as for *Fig. 1.* Mounted in Canada balsam.

Fig. 5. **Plexus Myentericus** of the Small Intestine (Guinea Pig). × **30.** The preparation shows the relatively regular and rectangular meshes of the plexus with ganglia at the knots. Fine branches of the nerves enter the muscular coat beneath (cf. Pl. 37, *Fig. 1*). **Technique** as for *Fig. 4,* the plexus remaining attached to one of the two muscular layers.

Fig. 6. **Tendon spindles** (Rabbit). × **50.** There is seen the junction of muscle and tendon. The dark staining of the striated muscle fibers below causes them and their rounded ends with numerous nuclei to stand out clearly from the tendon above. A nerve fiber coming from the muscle divides and each tendon spindle receives a branch, the termination of which is but incompletely revealed by the gold impregnation. **Technique** as for *Fig. 1.*

Fig. 7. **Muscle Spindle** (Cat). × **120.** The preparation shows a number of fine fibers of striated muscle surrounded by several nerve fibers which proceed from a thick nerve trunk. In addition to ordinary motor end plates (above) the nerve fibers form around the muscle fibers delicate flowerlike branchings and loops which are the real sensory endings of the muscle spindle. **Technique** as for *Fig. 1.*

art = artery
ep = epithelium
ga = ganglia
intrep = intra-epithelial nerves
ke = nuclei of motor end plates
ktz = nuclei of tactile cells
lea = anterior elastic membrane
m = intestinal muscle
me = motor end plate
mf = muscle fibers
mf_1 = muscle fibers of the muscle spindle
mf_2 = muscle fibers of the spindle cut lengthwise
mk = nuclei of muscle fibers
mn = nerve branches to the muscle
mt = rounded ends of the muscle fibers
n = small nerve to the muscle spindle
nf = nerve fiber
nf_1 = terminals of the nerve fiber between the tactile cells
nft = terminals of the nerve fiber in the muscle spindle
nn = nerves connecting the ganglia
sp = substantia propria corneae
ssp = tendon spindle
subep = subepithelial nerve plexus
te = tendon
tp = mucous membrane
ven = veins

Plate 37. **Nerve Endings II.**

Fig. 1. From the **Plexus Myentericus** (Rabbit). × **750.** Upon a background of smooth muscle there are seen several meshes of the plexus with groups of sympathetic nerve cells at the knots of the network. Delicate branches proceed from the meshes into the neighboring smooth muscle. **Technique** as for *Fig. 5*, Pl. 36.

Fig. 2. **Tactile Cells** in the Epidermis **(Snout of Pig).** × **750.** Epidermis above, corium below; through the latter a number of nerve fibers (dark) pass into the epidermis. Certain of the epidermal cells appear particularly clear (tactile cells) and with them the nerve fibers connect by forming disclike expansions (tactile discs). **Technique:** Gold impregnation as for *Fig. 5*, Pl. 36.

Fig. 3. **Free Nerve Endings** in Epithelium (Epidermis, **Nose of Dog**). × **200.** In the corium below is a dense nerve plexus from which fibers, singly or in small groups, enter into the epidermis to end freely between its cells. **Technique:** Potassium bichromate—osmic acid. Golgi's silver impregnation.

Fig. 4. **Vater-Pacinian Corpuscle** (Mesentery of Cat). × **45.** View of entire corpuscle in longitudinal optical section. The nucleated concentric lamellae become closer together toward the dark inner bulb and are easily recognized. **Technique:** Platinum chloride-osmo-acetic acid. Transferred to absolute alcohol. Cleared in origanum oil which through frequent changes has gradually dissolved the adjacent osmicated fat.

Fig. 5. Longitudinal Section of a **Corpuscle of Herbst** (Tongue of Duck). × **380.** The Herbst corpuscle although very small displays particularly well the structure of this type of corpuscular nerve ending; the neuroplasm of the inner bulb and the nuclei of the neurolemma are especially distinct. **Technique:** 1% osmic acid. Celloidin.

Fig. 6. Transverse Section of a **Vater-Pacinian Corpuscle** (Human, aet. 22. Execution), × **120.** From a section of skin from the palm of the hand. The inner bulb is very slender, the number of concentric lamellae very great. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 7. Two **Corpuscles of Grandry** (Tongue of Duck). × **450.** One corpuscle has two and the other has four tactile cells. The nerve fiber, as it enters the corpuscle, loses its medullary sheath and then expands into the tactile discs between the tactile cells. **Technique** as for *Fig. 5*.

ax = axis cylinder of the nerve fiber
bdh = nuclei of connective-tissue cells
cor = corium
ep = epithelium
glm = smooth muscle
ik = inner bulb
k = nuclei of epidermal cells
lae = external lamellae
lai = internal lamellae
mnf = medullated nerve fibers
nk = nuclei of neurolemma
nz = nerve cells
tm = tactile menisci
tsch = tactile discs
tz = tactile cells
vbs = nerve cords connecting ganglia

Tab. 37

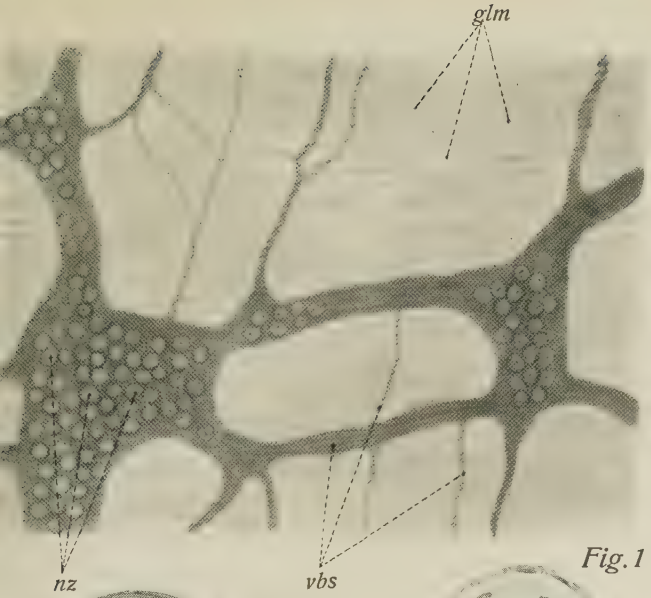

Fig. 1

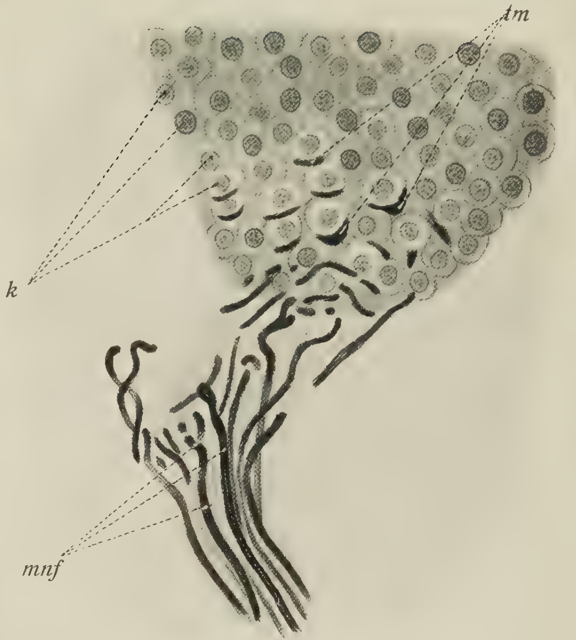

Fig. 2

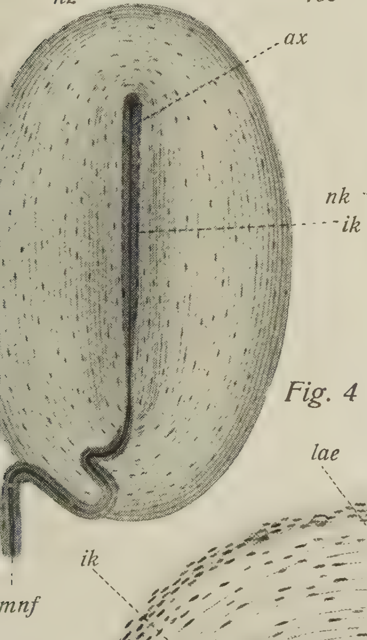

Fig. 4

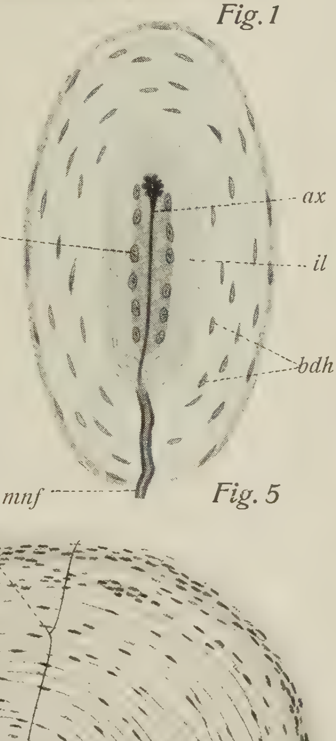
ax
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Fig. 5

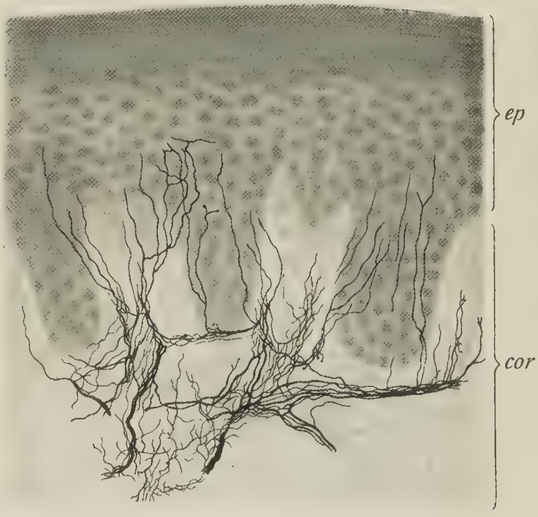

Fig. 3

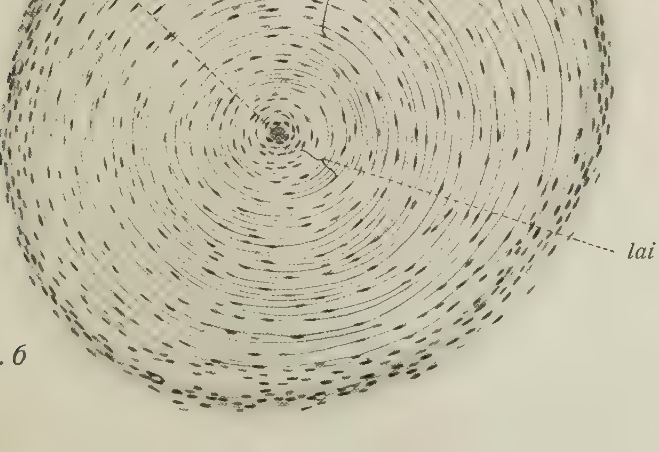

Fig. 6

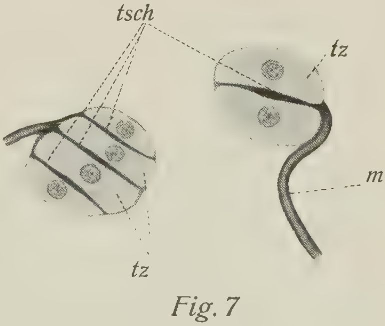
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Fig. 7

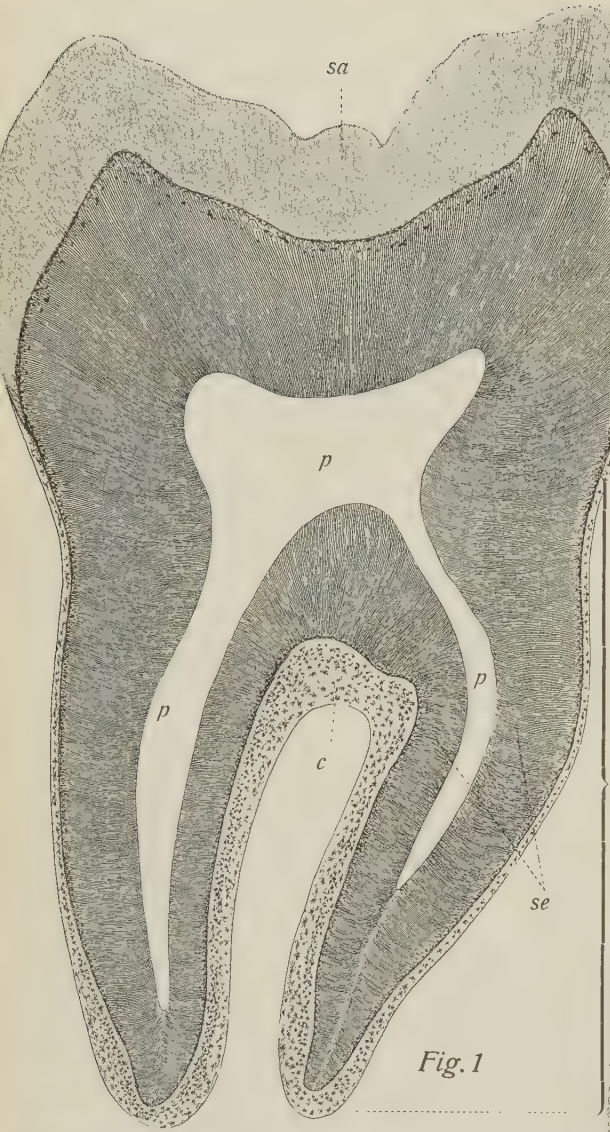
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Fig. 1

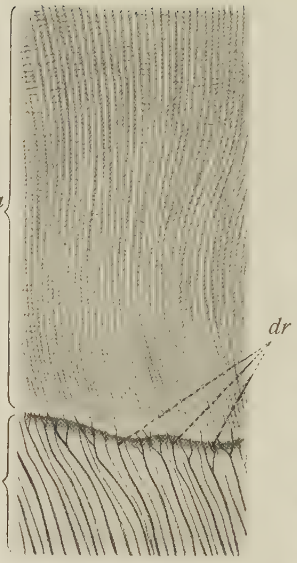

Fig. 2

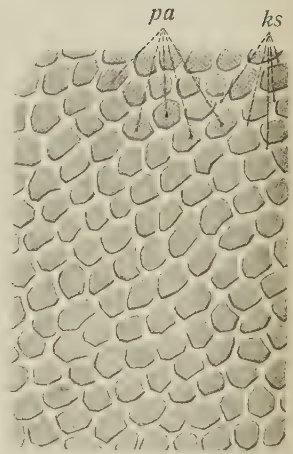

Fig. 4

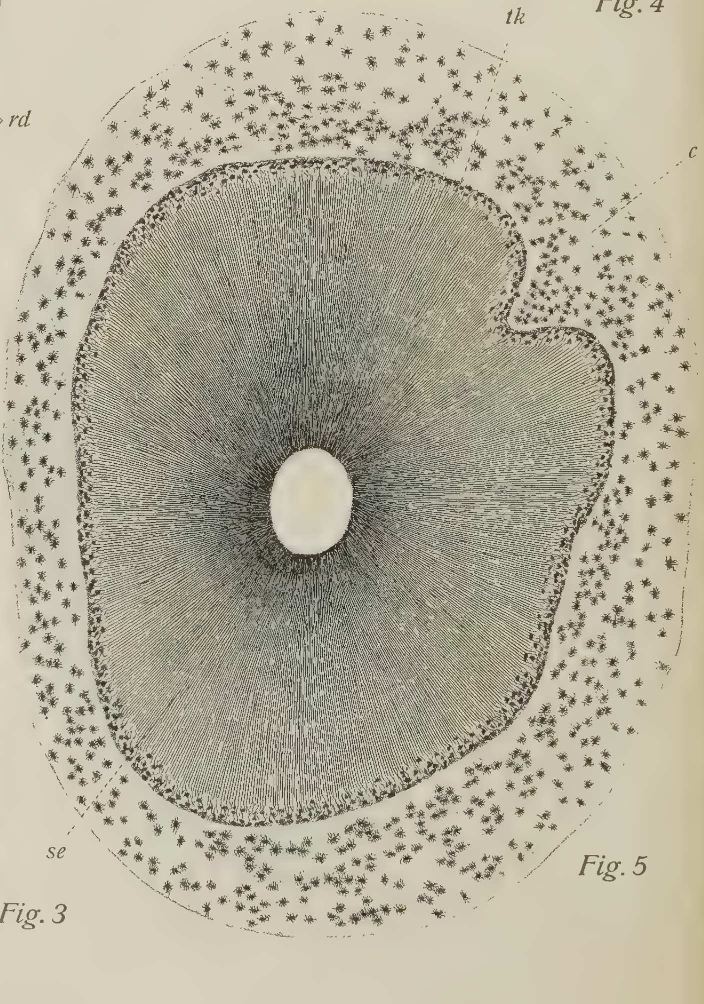

Fig. 5

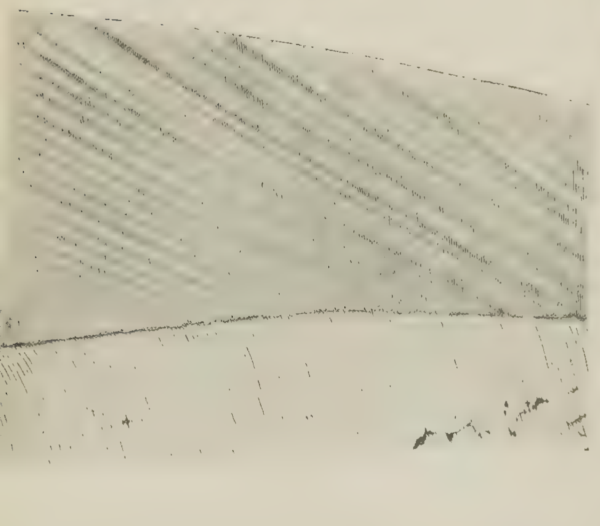

Fig. 3

Plate 38. **Tooth I.**

Fig. 1. **Longitudinal Section of a Human Molar Tooth. × 8.** General view of the structure of a tooth showing crown, neck and root, and the distribution of its three chief constituents: enamel, dentine, and cement. The pulp cavity is visible throughout almost its entire extent, only the foramina apicium not being present in the section. Notwithstanding the low enlargement the interglobular spaces appear as small black points and spots forming a definite zone. **Technique:** A slice is sawn from a tooth, ground upon a stone to the requisite thinness and polished with talc upon leather. No medium is used in mounting. (Caution! Sections of the entire tooth easily break in two. It is much more difficult to make longitudinal sections than sections across a root.)

Fig. 2. Part of a **Longitudinal Section from the Crown of a Human Incisor Tooth. × 180.** There are seen the parts of the enamel and dentine adjacent to their line of contact. The enamel prisms are striated transversely and are distinctly curved. The outer ends of the dentinal canals are clearly seen to run between the enamel prisms. **Technique** as for *Fig. 1.* Mounted in acid Canada balsam.

Fig. 3. Part of a **Longitudinal Section of a Human Incisor Tooth. × 45.** In the enamel the parallel lines of Retzius show distinctly. Because of the low enlargement the enamel prisms appear only as a fine striation. **Technique** as for *Fig. 2.*

Fig. 4. Part of a **Transverse Section** of the Crown of a Human Molar Tooth. × **850.** Only the enamel of the preparation is shown. Under this high enlargement it appears as rather regular areas which are the cross sections of the enamel prisms. These are long irregularly hexagonal columns which are often grooved. Between the cross sections of the individual prisms is seen an especially large amount of cement substance (action of the acid). **Technique** as for *Fig. 2.* Because of the brittleness of the enamel only thick discs of the crown can as a rule be made by the saw so that most of the work has to be done upon the rubbing stone; even so the enamel often crumbles.

Fig. 5. **Transverse Section of the Root of a Human Canine Tooth. × 25.** General view of the structure of the root of a tooth. The pulp cavity in the middle is empty; the dentinal canals and the lacunae of the cement are black since they contain air. **Technique** as for *Fig. 1.*

c = cement
cold = neck of tooth
cor = crown of tooth
dr = dentinal canals
ks = cement substance
p = pulp cavity
pa = enamel prisms
rd = root of tooth
sa = enamel
se = dentine
tk = Tomes' granular layer

Plate 39. **Tooth II.**

Fig. 1. Part of a **Longitudinal Section of the Crown** of a Human Premolar Tooth. **Enamel-Dentine Contact. × 200.** On the left is the enamel, the prisms of which follow a slightly wavy course. On the right the dentine shows the dentinal canals which branch frequently as they near the enamel boundary; their finest terminal branches often extend between the enamel prisms. Near the boundary of enamel and dentine, but at a distinct distance from it, lie two larger and two smaller interglobular spaces which like the dentinal canals contain air and as a result appear black by transmitted light. **Technique:** Ground section.

Fig. 2. Part of a **Longitudinal Section from the Root** of a Human Molar Tooth. **Dentine-Cement Contact. × 200.** On the left is the cement containing lacunae (black); on the right is the dentine, the dentinal canals of which show numerous short branches. The most external branches do not reach the margin of the cement but enter a layer which is in immediate contact with the dentine. This, the so-called Tomes' granular layer, contains numerous very small interglobular spaces which produce a granular appearance in the section. **Technique:** Ground section.

Fig. 3. Part of a Longitudinal Section of a Decalcified Human Deciduous Tooth. **Pulp-Dentine Contact. × 350.** On the left is the dentine in which an outer, darker, more strongly calcified zone is to be distinguished from an inner, paler zone which is but slightly calcified. On the inner surface of the latter zone is the layer of odontoblasts, the strikingly regular arrangement of which produces the appearance of an epithelium. The nuclei as a whole lie toward the pulp; the processes (dentinal fibers) are barely indicated. On the right is the pulp with a thin-walled blood vessel and connective tissue rich in cells. **Technique:** Müller's fluid. Decalcification in hydrochloric acid. Borax carmine.

Fig. 4. Isolated **Odontoblasts** from the Pulp Cavity of a Deciduous Tooth (Child, aet. 2). **× 1000.** The nuclei look toward the pulp cavity while from the opposite side of the cell there proceeds the so-called dentinal fiber; *i. e.* the projection of the protoplasm of the cell which enters the dentinal canal. **Technique:** Teased from pulp fixed in Müller's fluid. Picrocarmine. Mounted in glycerine.

Fig. 5. Part of a Transverse Section of the Root of a Tooth Decalcified along with the Alveolar Bone. **Ligamentum Circulare Dentis. × 160.** Beneath are the lamellae of the alveolar bone with their noticeable abundance of cells; above are the superficial layers of the wall of the root of the tooth; the alveolar periosteum lies between, forming the so-called circular ligament of the tooth. In the wall of the tooth itself an area of dentine is to be distinguished from the covering of cement, here very thin and apparently composed of lighter and darker zones. Tomes' granular layer appears as a dark line at the contact of dentine and cement. Sharpey's fibers in close formation are seen to emerge from the alveolar bone, pass perpendicularly into the fibrous mass of the circular ligament applied to the wall of the tooth and enter into the cement. Just here the latter is devoid of cells. **Technique** as for *Fig. 4.*

Fig. 6. Supplementary figure to the development of a tooth (see Pl. 40). **Cells from the Enamel Pulp** of the Enamel Organ (Human Embryo of 6 Months). × **280.** The stellate form which, exception ally, the epithelial cells here assume, is clearly seen, also the great quantity of intercellular substance between the cells. **Technique:** Müller's fluid. Celloidin. Delafield's haematoxylin.

ce = cement (as yet lacking cells)
bg = blood vessel
de = dentine
de_1 = young dentine slightly calcified
dk = dentinal canals
f = protoplasmic processes of the odontoblasts
ig = interglobular spaces
k = nuclei
kh = lacunae
kn = alveolar bone
kö = Tomes' granular layer
od = odontoblasts
per = periosteum
pr = protoplasm
pu = pulpa dentis
s = enamel
sp = enamel prisms

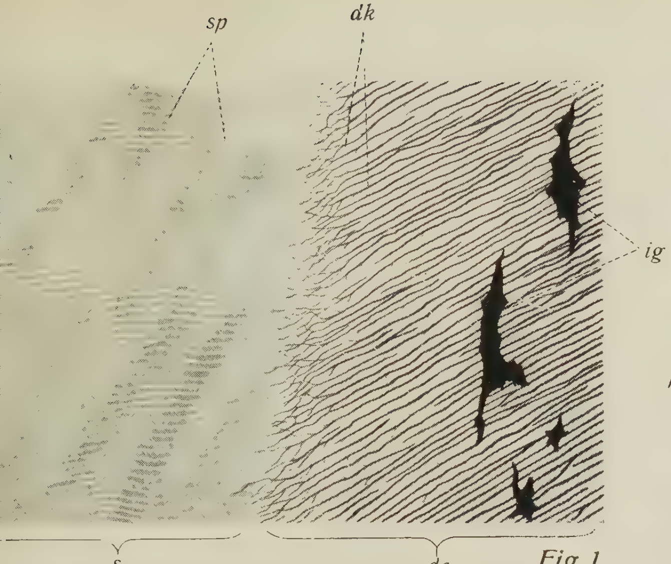

Fig. 1

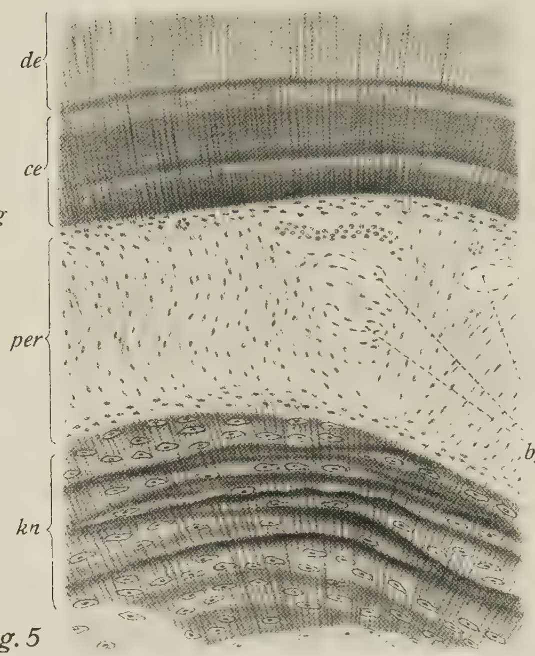
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Fig. 5

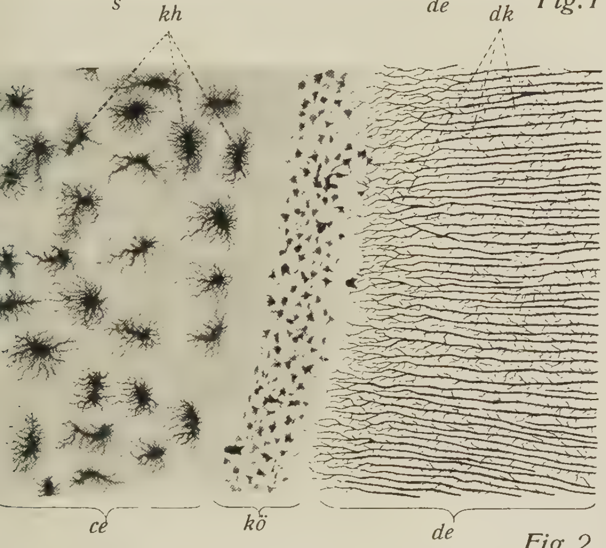
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Fig. 2

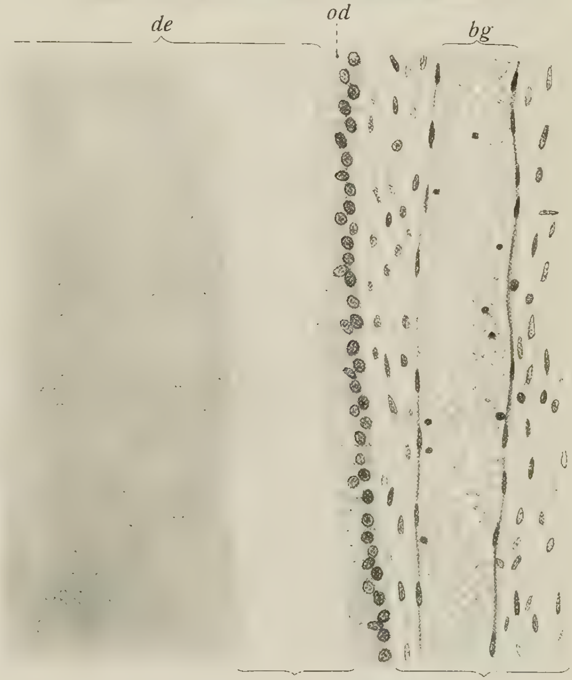
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Fig. 3

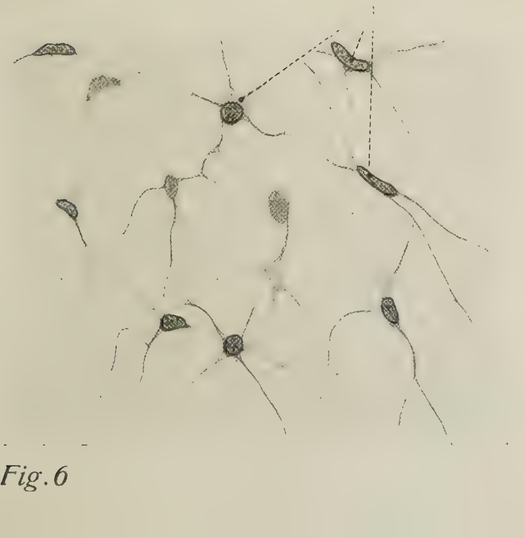

Fig. 6

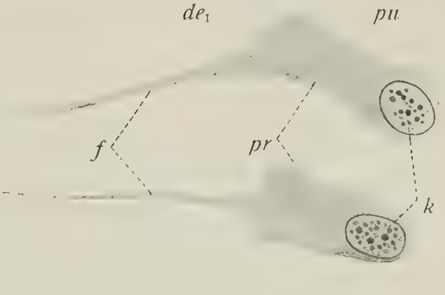

Fig. 4

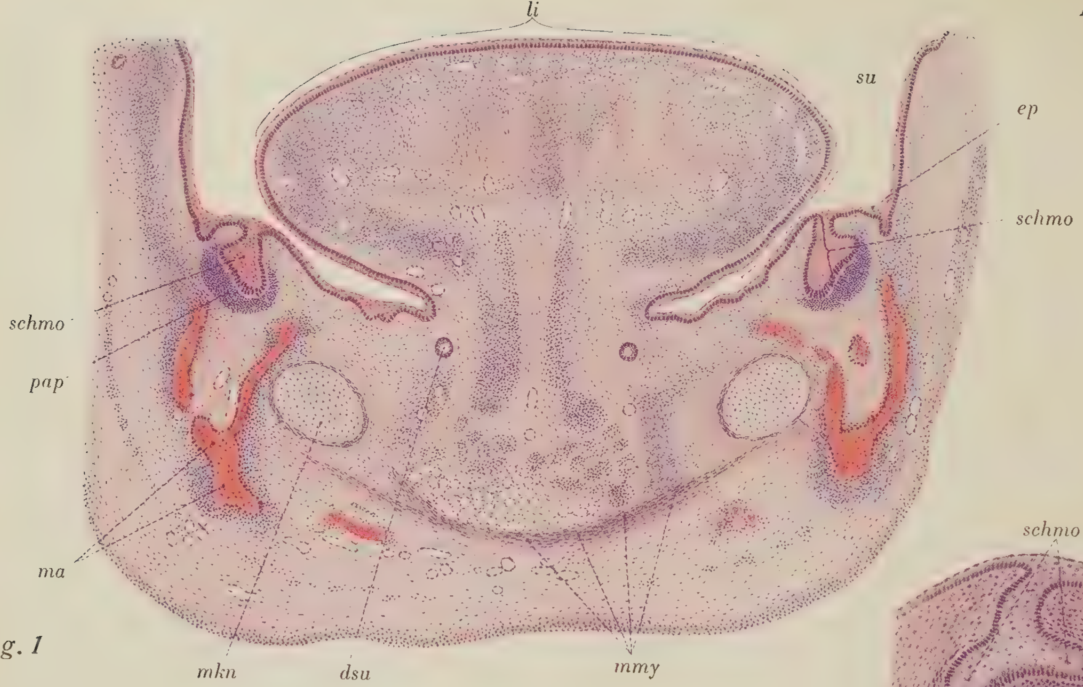
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Fig. 1

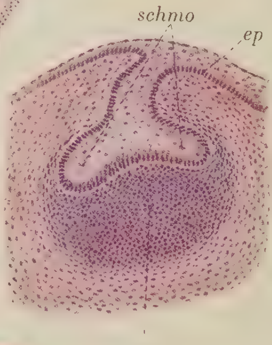
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Fig. 2

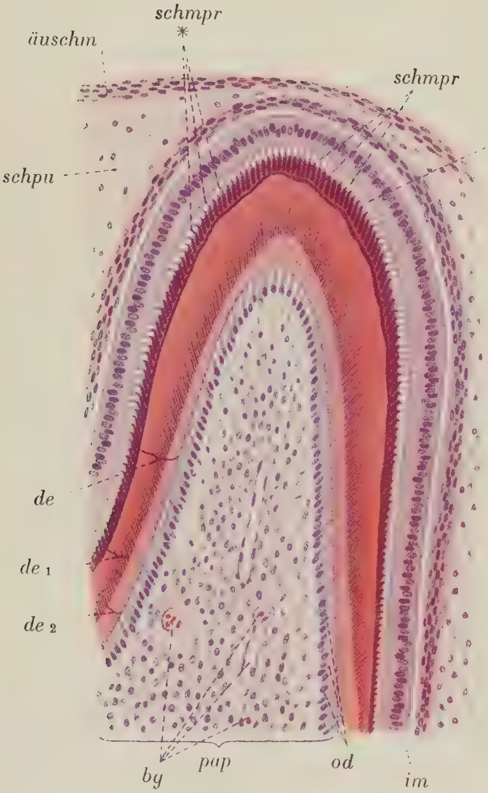
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Fig. 4

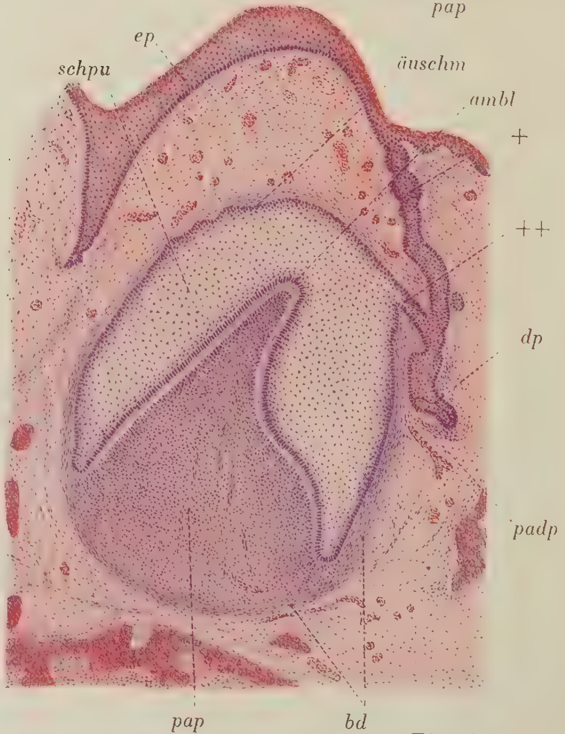
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Fig. 3

Plate 40. **Development of a Tooth I.**[1]

Fig. 1. Frontal Section through Tongue and Lower Jaw (Human Embryo of the Third Month). **Early Stage of the Development of a Tooth.** × **35.** The embryonic tongue is seen in the middle of the section; on each side in the floor of the mouth is Meckel's cartilage and the anlage of the membrane bone of the lower jaw. From the epithelium of the floor of the mouth (dental shelf) there projects on each side the young anlage of the tooth consisting of enamel organ and the anlage of the papilla. **Technique:** Picro-sublimate. Paraffine. Haematoxylin-eosin.

Fig. 2. **Anlage of a Tooth** from the Same Section as *Fig. 1.* × **80.** The epithelial enamel organ is already slightly cupped, its basal cells are cylindrical and at the crest of the curve the nuclei form several layers. Below is the densely cellular tissue of the connective-tissue papilla. As yet there is no differentiation of odontoblasts. **Technique** as for *Fig. 1.*

Fig. 3. A Section through the **Anlage of a Deciduous Incisor** (Human Embryo of Four to Five Months). × **40.** The anlage of the tooth is decidedly further developed than that of *Fig. 2* but no hard substance has as yet been formed. Above is the epithelium of the mouth cavity from which there extends downward the dental (or enamel) shelf forming the so-called neck of the enamel organ. At its lower end (on the right) is seen the anlage of the corresponding tooth of the permanent dentition and a little above (indicated by + +) there branches off its connection with the enamel organ of the anlage of the deciduous tooth. The base of the enamel organ is deeply invaginated by the conical papilla and is formed of a single layer of high columnar cells, the inner enamel cells or adamantoblasts. Externally the enamel organ consists of several layers of flat outer enamel cells; while the interval between these and the inner enamel cells is filled by the enamel pulp formed of stellate cells and abundant intercellular substance. Odontoblasts are forming on the surface of the connective tissue papilla. Beneath the anlage of the tooth are trabeculae of bone and around it the connective tissue of the dental sac. **Technique** as for *Figs. 1 and 2.*

Fig. 4. Part of a Section from the **Crown of the Anlage of a Deciduous Tooth** (Human Embryo of 6 Months). × **165.** Only the tip of the later crown is represented (the entire picture would correspond to that of *Fig. 3*). The formation of the hard parts has begun. The adamantoblasts have secreted young enamel prisms, so-called Tomes' processes, the substance of which appears darker and more calcified the older, *i. e.* the further removed from the mother cell, it becomes. On the surface of the papilla is a layer of odontoblasts arranged in a row; these form the young dentine. An inner, younger layer of predentine, pale because only slightly calcified, is to be distinguished from a darker, well calcified zone. Between the dentine and Tomes' processes is a delicate homogeneous limiting membrane. The tip of the anlage of the tooth (in the narrower sense) with the adamantoblasts has almost crowded out the enamel pulp so that the adamantoblasts are almost in direct contact with the outer enamel cells. **Technique:** Müller's fluid. Decalcification in hydrochloric acid. Haematoxylin-eosin.

ambl = ameloblasts (adamantoblasts)
äuschm = outer enamel cells
bd = connective tissue
dp = anlage of permanent tooth
dsu = duct of gland
ep = epithelium
de = dentine
de_1 = older dentine
de_2 = young dentine
im = intermediate layer
li = tongue
ma = anlage of mandible
mkn = Meckel's cartilage
mmy = musculus mylohyoideus
od = odontoblasts
padp = anlage of papilla of permanent tooth
pap = papilla
schmo = enamel organ
schmpr = enamel prisms
schpu = enamel pulp
su = furrow between tongue and dental shelf
+ = neck of enamel organ
++ = branch to enamel organ of milk tooth

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[1] See also the diagrammatic figures No. 24 and 25, vol. I.

Plate 41. **Development of a Tooth II, Lip. I.**

Fig. 1. **Deciduous Tooth and Anlage of Permanent Tooth** (New Born Child). × **12.** General view of the state of development of a deciduous incisor and of the corresponding permanent tooth at the time of birth. Note that as regards the deciduous tooth no anlage of either neck or root is to be seen, even the crown has but recently taken shape notwithstanding the cap of dentine and enamel which increases markedly in thickness toward the future exposed surface of the tooth. Considerable remains of the enamel pulp are still to be seen beyond the point where the hard parts have been formed. Dentine is stained red and enamel violet. Where the hard parts have already attained considerable thickness the only relics of the enamel organ are the ameloblasts which in the preparation have been artificially pulled away from the enamel. The anlage of the permanent tooth has not as yet formed any hard parts, it is in the stage of development of *Fig. 3*, Pl. 40. Beneath the epithelium of the mouth cavity is a so-called glandula tartarica or epithelial pearl. **Technique:** Müller's fluid. Decalcification in hydrochloric acid. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of the **Deciduous Tooth** pictured in *Fig. 1.* × **125.** The figure shows a portion of the cap of enamel, the entire thickness of the dentine and the layer of odontoblasts belonging to the papilla. The dentinal fibers proceeding from the odontoblasts are distinctly shown and both the younger and the older layers of dentine. **Technique** as for *Fig. 1.*

Fig. 3. Sagittal Section through the **Upper Lip** (Human, aet. 28. Execution). × **8.** General view under low enlargement. Above is the mucous membrane of the lip, below is the skin and at the left the red margin. In the skin are hairs and cutaneous glands; while in the deeper layers of the mucous membrane there are seen four labial glands, one above another. The musculature of the lip occupies the middle area and reaches the red margin where also occurs the transition from skin to mucous membrane, the epidermis changing into the thick stratified squamous epithelium of the oral mucous membrane. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

ai = inner enamel cells (adamantoblasts)
art = labial artery
ba = hairs
de = dentine
de_1 = older dentine
de_2 = young dentine
def = dentinal fibers
ep = oral epithelium
fac = facies cutanea labii
fad = facies dentalis labii
glla = labial glands
glt = so-called glandula tartarica
kn = bone
lr = red margin of lip
mu = musculature of lip
od = odontoblasts
pa_1 = papilla of milk tooth
pa_2 = papilla of permanent tooth
pu_1 = enamel pulp of milk tooth
pu_2 = enamel pulp of permanent tooth
sa = enamel
schmo = enamel organ
zlr = remains of dental shelf
+ = remains of cartilage
* = duct of gland

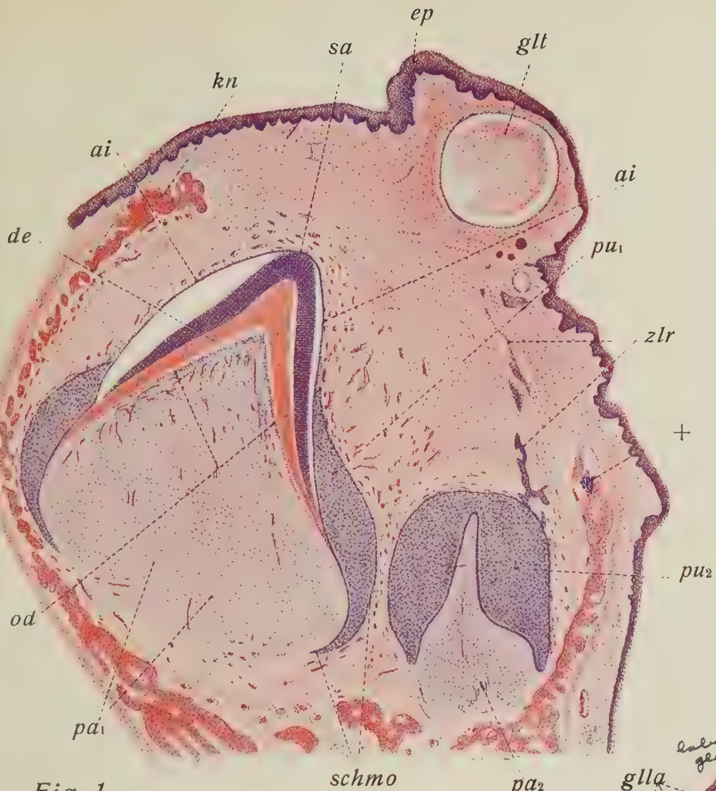
ep
sa
glt
kn
ai
ai
de
pu1
zlr
+
pu2
od
pa1
schmo
pa2

Fig. 1

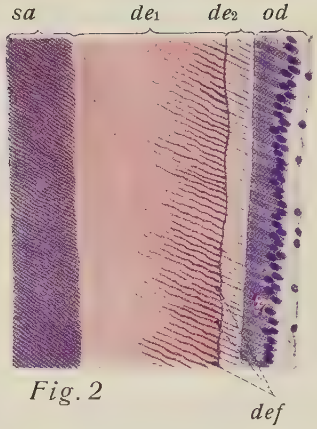
sa
de1
de2
od
def

Fig. 2

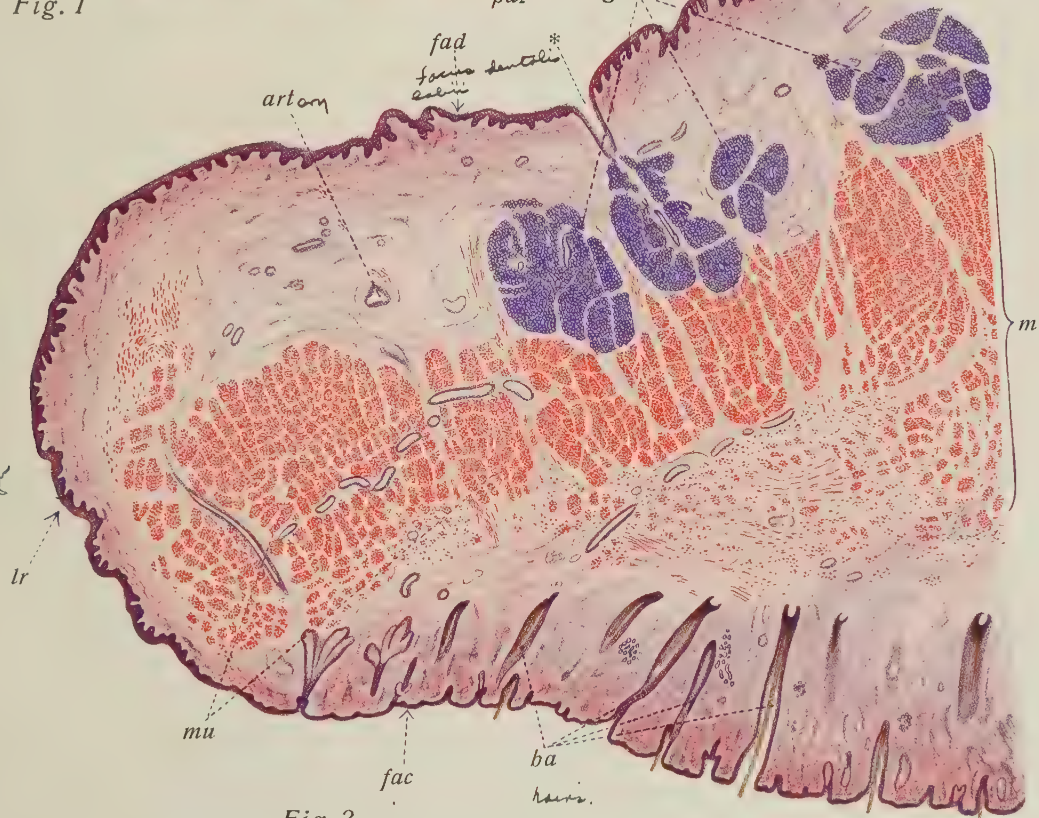
labial glands.
glla
*
fad
fossa dentalis labii
artery
mu
margin
lr
mu
fac
ba
hairs.

Fig. 3

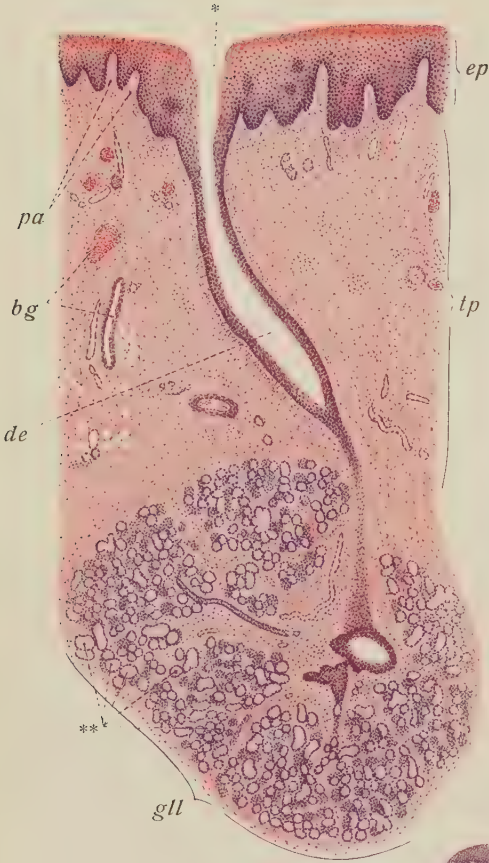
*
ep
pa
bg
tp
de
**
gll

Fig. 1

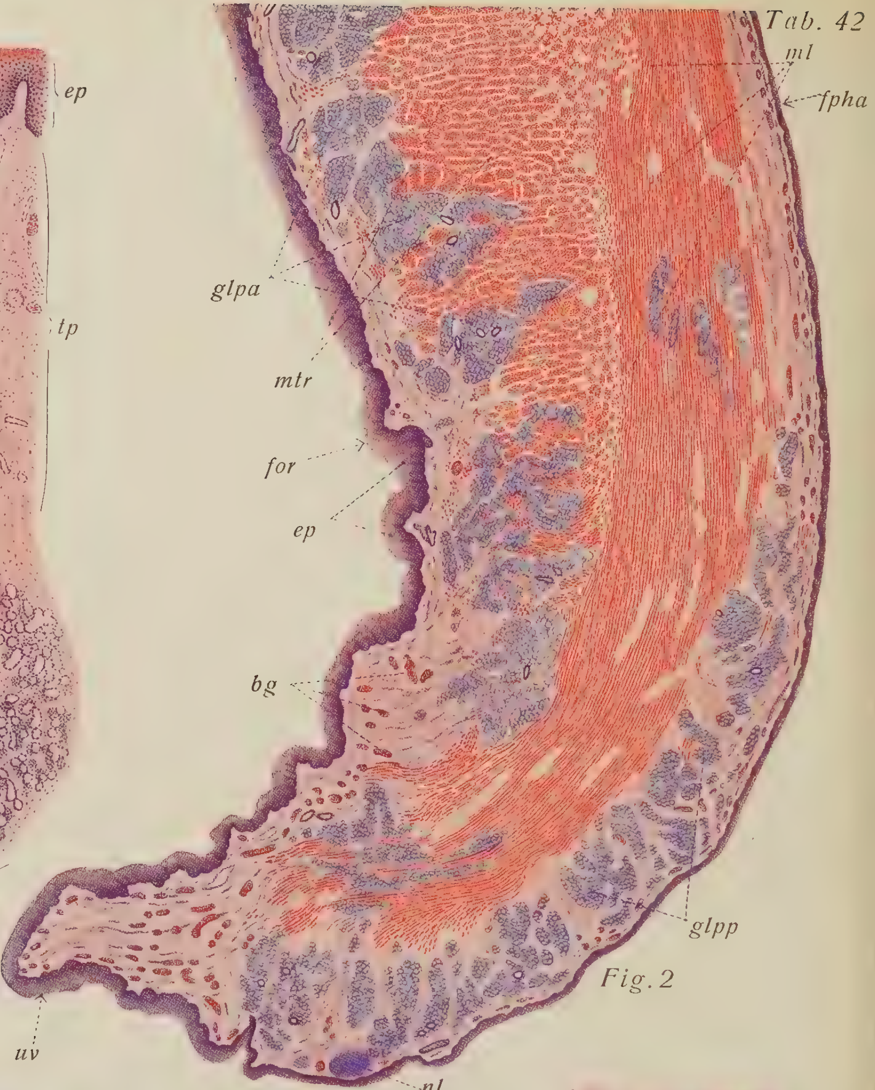
ml
fpha
glpa
mtr
for
ep
bg
glpp
uv
nl

Fig. 2

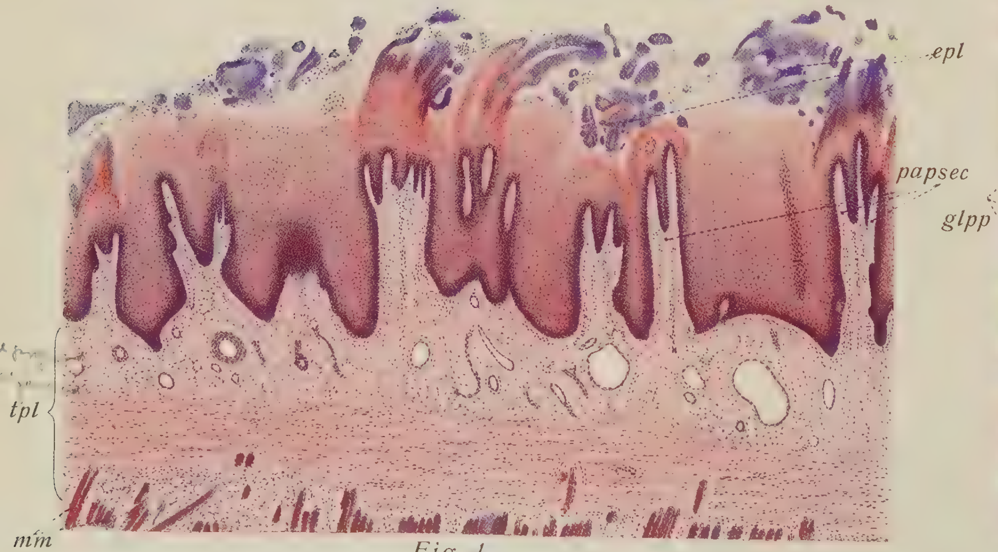
epl
papsec
tpl
mm

Fig. 4

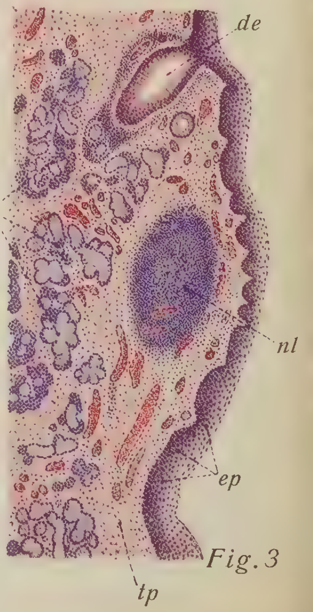
de
glpp
nl
ep
tp

Fig. 3

Plate 42. **Lip II, Palate, Tongue I.**

Fig. 1. Part of a Section of a **Human Upper Lip.** × **30.** Detail of *Fig. 3*, Pl. 41. The figure shows the mucous membrane of the lip and a labial gland. The duct of the latter is visible throughout the greater part of its length, the detail of its opening upon the surface of the mucous membrane is especially clear. **Technique** and source as for *Fig. 3*, Pl. 41.

Fig. 2. Sagittal Section of the **Velum Palatinum and Uvula** (Human, aet. 21. Execution). × **7,5.** General view under quite low enlargement. On the left the oral surface shows a very thick stratified squamous epithelium which is continued over the pharyngeal surface of the uvula. Elsewhere on the right the surface of the soft palate bears a thin stratified squamous epithelium with low papillae except at the upper end of the figure where it becomes a stratified ciliated epithelium. The oral mucous membrane is rich in glands of a purely mucous nature while the pharyngeal surface contains many glands only in its lower portion. These latter glands are of a mixed (muco-serous) nature. The uvula proper is entirely devoid of glands. The mucous membrane of the pharyngeal surface also contains diffuse lymphatic tissue. Down the center of the preparation runs the striated musculature of the soft palate with the deeper parts of the glands embedded within it. **Technique:** Müller's fluid—formol. Celloidin. Haematoxylin-eosin.

Fig. 3. Part of a Section of the Human **Soft Palate.** × **30.** Detail of *Fig. 2*. The figure shows a part of the mucous membrane of the pharyngeal surface with a small lymph nodule, a duct, and part of a gland which displays clearly its mixed character. (The glands of the oral surface are purely mucous.) **Technique** as for *Fig. 2*.

Fig. 4. From a Sagittal Section through the **Anterior Part of the Dorsum of the Tongue (papillae filiformes).** × **25.** There are seen a number of filiform papillae, some of which are cut very superficially; while others show the typical picture in which points formed of secondary papillae from the tunica propria, are covered by an extremely thick layer of stratified squamous epithelium. The long conical points of the filiform papillae are thus often curved and subdivided. In the section the superficial squamous cells are cut through in varied and irregular patterns which stand out here and there in the figure as masses and clumps of cells. The tunica propria contains many blood vessels and some fat, and passes without demarcation into the so-called lingual fascia or aponeurosis, into which at the very bottom of the figure the ends of the striated muscle fibers are inserted. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

bg = blood vessels
de = duct
ep = epithelium
epl = epithelial masses on the points of the filiform papillae
for = oral surface of soft palate
fpha = pharyngeal surface of soft palate
gll = labial gland
glpa = glands of anterior surface of soft palate
glpp = glands of posterior surface of soft palate
mm = muscle fibers
ml = longitudinal muscle of soft palate
mtr = oblique muscle fibers of soft palate
nl = lymphatic nodule
pa = papillae
papsec = secondary papillae
tp = tunica propria
tpl = tunica propria and fascia linguae
uv = tip of the uvula
* = opening of duct of labial gland
** = alveoli of labial gland

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Plate 43. Tongue II.[1]

Fig. 1. **Fungiform and Filiform Papillae** from a Section Perpendicular to the Anterior Part of the Dorsum of the Tongue. × **60.** Three filiform papillae are seen cut almost axially; their conical desquamating masses of epithelium rest on the tops of the papillae. Between them is a noticeably higher fungiform papilla with narrow base and broad top. The epithelial surface is smooth in contrast to that of the filiform papillae. The broad, connective-tissue axis forms secondary papillae only toward the free surface. Quite at the bottom of the figure are two fibers of striated muscle (red). Note that the tunica propria in this region of the tongue is completely free from glands. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Vertical Section through a **Papilla Vallata** of the Human Tongue. × **42.** The broad but low papilla is surrounded as by a moat (++) and embankment; the bulky tunica propria which forms the axis of the papilla extends into the epithelium as well marked secondary papillae. Small nerves and groups of nerve cells are clearly visible. Below, lying quite at the base of the papilla and in part between the more superficial bundles of muscle, are small serous glands, the so-called Ebner's glands. Taste buds appear as clear spots in the relatively low epithelium which lines the moat. **Technique** as for *Fig. 1.*

Fig. 3. Vertical Section through an Unusually Well Developed Human **Papilla Foliata.** × **22.** Right and left are seen low folds and in the center higher ones, all cut transversely and covered by a thick epithelium. In this epithelium, and especially on the lateral surfaces of the higher, middle folds, there are seen taste buds as clear spots which are often arranged one above another in rows. Beneath the papillary layer, and in part even between the bundles of the superficial muscular layer (red) are seen a few small serous glands. The connective-tissue cores of the folds have low secondary papillae. **Technique** as for *Fig. 1.*

calg = taste buds
ep = epithelium
epd = desquamating epithelium
fol = folds of the papilla foliata
gl = glands
nz = nerve cells
pafi = papillae filiformes

pafu = papilla fungiformis
pase = secondary papillae
pav = papilla vallata
qmf = fibers of striated muscle
tp = tunica propria
tpsp = tunica propria with secondary papillae
++ = furrow

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[1] The preparations represented in *Figs. 1, 2, and 3* are derived from individuals who had been executed at the ages of 50, 28 and 21 years respectively.

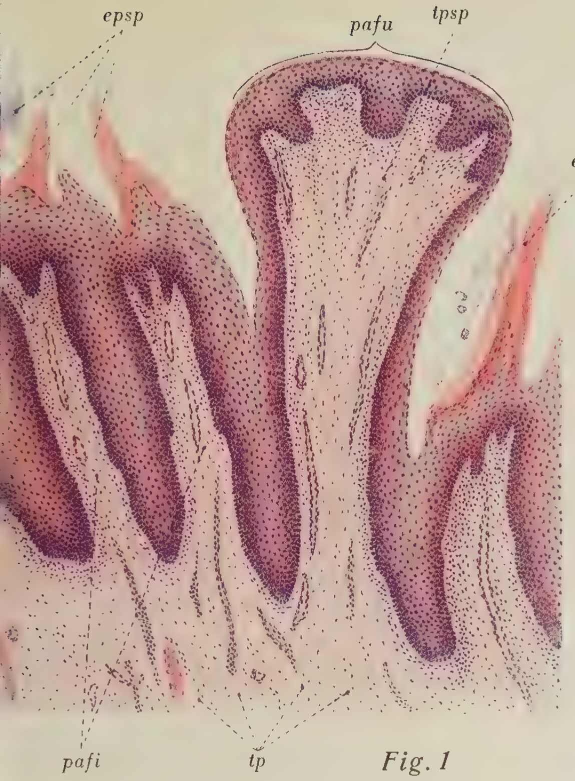

epsp
pafu
tpsp
epsp
pafi
tp

Fig. 1

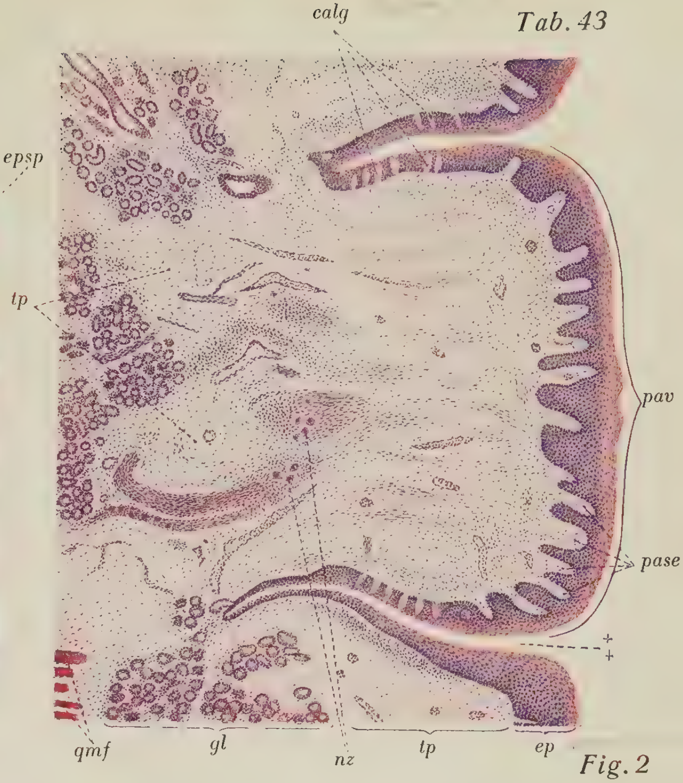

calg
tp
pav
pase
+
+
qmf
gl
nz
tp
ep

Fig. 2

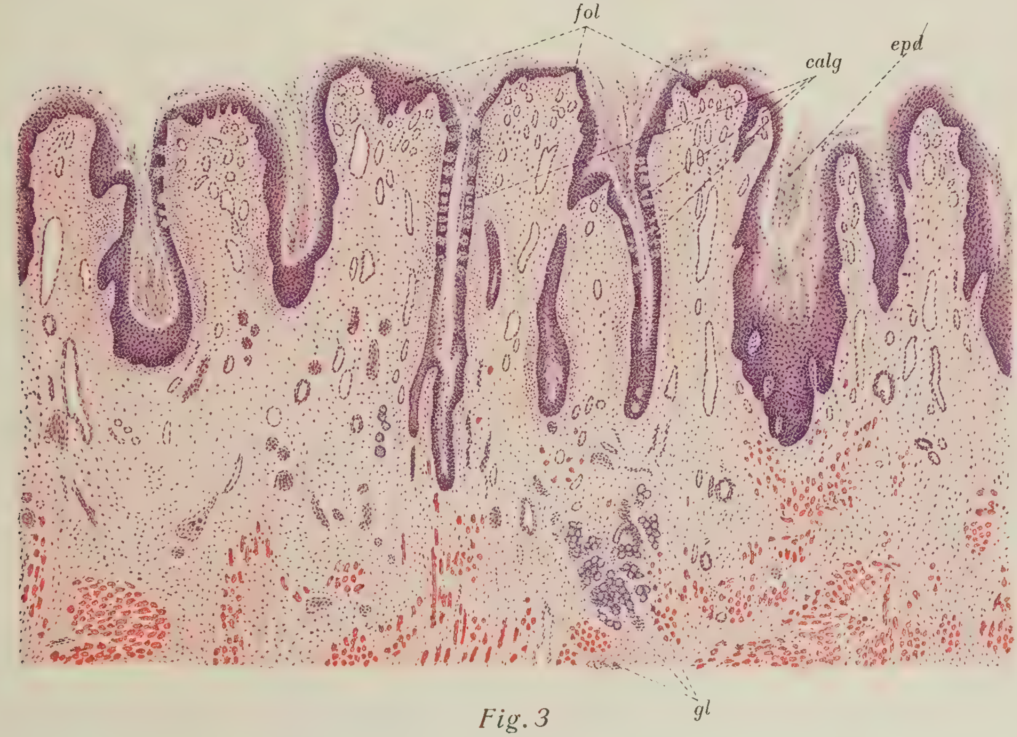
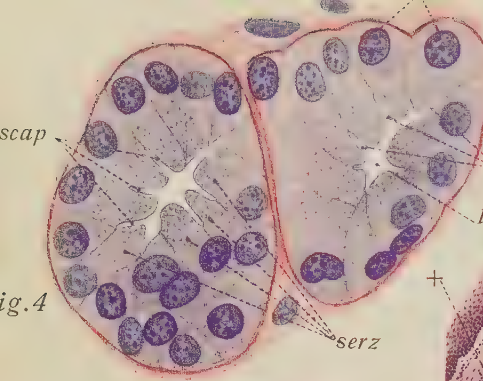

fol
calg
epd
gl

Fig. 3


scap
scap
ls
serz

ig.4

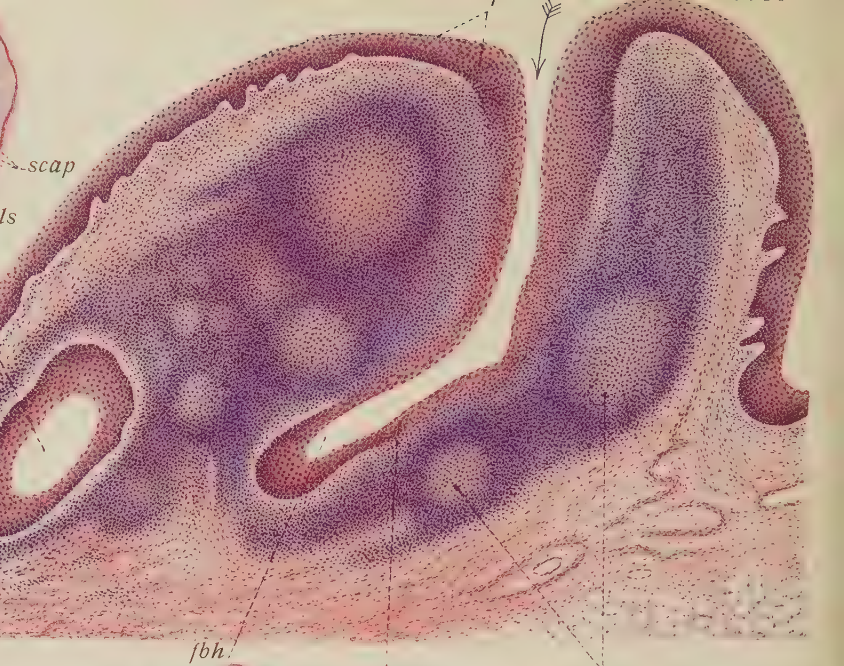


Fig.1

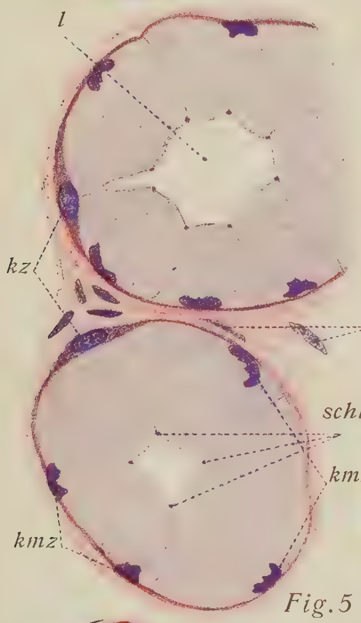

l
kz
bk
schll
kmz
kmz

Fig.5

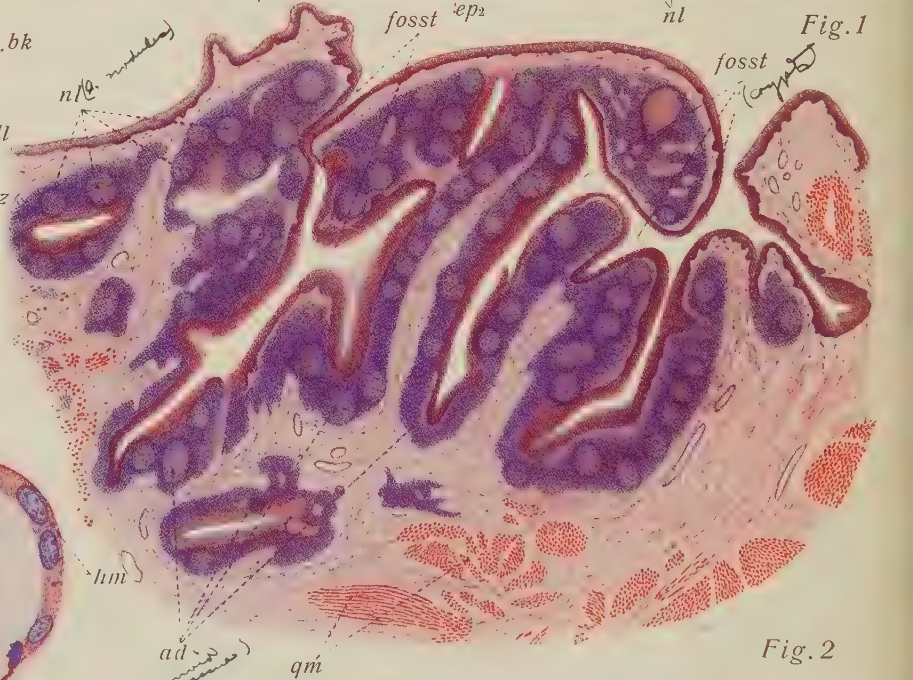
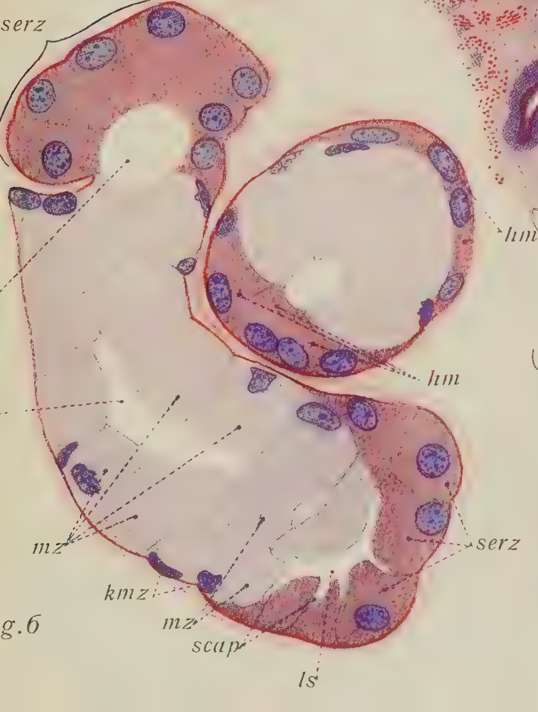

nl (l. nodules)
fosst
fosst (crypts)
lm
ad (adenoid tissue)
qm

Fig.2


serz
lm
mz
serz
kmz
mz
scap
ls

g.6

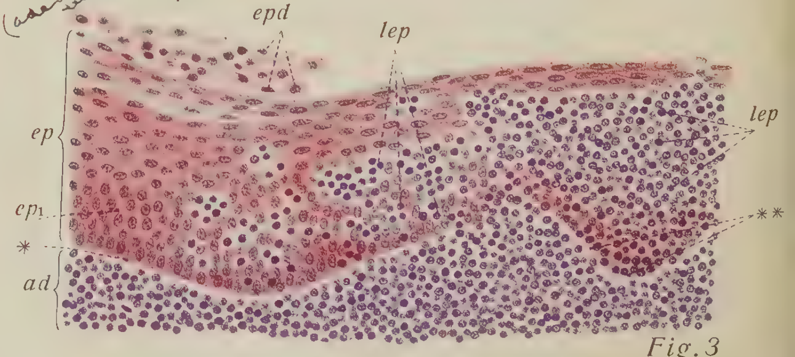

epd
lep
lep
ep
ep₁
*
**
ad

Fig.3

Plate 44. Tonsils, Salivary Glands I.

Fig. 1. Vertical Section through a **Lingual Tonsil** (Human, aet. 22. Execution) × **35.** General view of a lingual tonsil with its crypt; the wall of the crypt is of adenoid tissue with scattered lymph nodules and germinal centers. The epithelium lining the crypt is infiltrated with leucocytes. On the left is the large duct of a neighboring mucous gland. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Longitudinal Section through a **Palatine Tonsil** (Human, aet. 22. Execution). × **8.** General view of the palatine tonsil with its crypts bordered by adenoid tissue, its connective-tissue septa and the adjacent palatal musculature. Note that the adenoid tissue has no capsule but is separated from the underlying muscle by connective tissue only. **Technique:** Zenker's fluid. Celloidin. Boehmer's haematoxylin and eosin.

Fig. 3. From a Section Perpendicular to the **Mucous Membrane of a Tonsillar Crypt.** × **220.** (Part of the preparation pictured in *Fig. 2.*) The figure shows the epithelium infiltrated by manes of lymphocytes. On the left are a few lymphocytes, in the middle are scattered groups, while on the right they occur in large nests and have rendered the basal membrane of the epithelium indistinguishable. **Technique** as for *Fig. 2.*

Fig. 4. A Section of Two Adjacent **Serous Alveoli** from a Small Lingual Gland (Human, Execution). × **750.** Typical structure of the terminal secreting parts of serous salivary glands. From the narrow lumen, intercellular secretion canaliculi extend between the general secretion zones of the gland cells. Within the zones are distinct granules. The nuclei lie in the basal, non-granular zones of the cells and are round, not flattened. Surrounding the cells is the membrane propria. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 5. A Section of Two Adjacent **Mucous Alveoli** from a Small Lingual Gland (Base of the Human Tongue). × **750.** The lumen is wide; the gland cells large and clear; the cement lines thicken toward the surface to form terminal bars. The nuclei of the gland cells are flattened and notched, and lie close to the membrana propria, between which and the basal surface of the glandular cells basket cells are visible. **Technique** as for *Fig. 4.*

Fig. 6. Longitudinal Section through Two Adjacent Secreting Parts of the **Sublingual (Mixed Muco-serous) Gland.** × **750.** One of the terminal parts is cut lengthwise for a distance, the other is cut transversely. In both there are seen serous and mucous gland cells side by side. The former appear in this case to be rather evenly granular. Compare the two types of gland cells, of which the serous cells appear in part as the so-called crescents. The picture recalls what was shown in *Figs. 4 and 5* separately. **Technique** as for *Fig. 4.*

ad = adenoid tissue
bh = crypt
bk = nuclei of connective tissue
ep = epithelium
ep_1 = epithelium free from lymphocytes
ep_2 = epithelium into which lymphocytes have wandered
epd = desquamated epithelial cells
fbh = bottom of crypt
fosst = tonsillar crypts
hm = crescents
kmz = nuclei of mucous cells
kserz = nuclei of serous cells
kz = basket cells
l = lumen
lep = lymphocytes in the epithelium
lm = lumen of mucous secreting tissue
lms = lumen of muco-serous secreting tissue
ls = lumen of serous secreting tissue
mz = mucous cells
nl = lymphatic nodules
qm = striated muscle
scap = secretion canaliculi
schll = terminal bars
serz = serous cells
+ = duct of a gland
* = clear-cut boundary between epithelium and adenoid tissue
** = the boundary here is blurred

Plate 45. **Salivary Glands II.**[1]

The Three Large Salivary Glands.

Fig. 1. Part of a Section from a **Parotid Gland.** × **80.**

In the interlobular connective tissue a small artery and a larger branch of the excretory duct are visible. The lobule itself is composed of almost purely alveolar secreting parts pressed closely together, between which are visible scattered fat cells, a few secretory ducts (red), and a number of intermediate ducts of fine caliber (blue). **Technique:** Absolute alcohol. Paraffine. Haematoxylin-eosin.

Fig. 2. From a Section of **Parotid Gland.** × **300.**

A number of alveoli are seen, only a few of which show their very narrow lumen. In the center is seen a small secretory duct with typical acidophile cells striated radially in their basal parts. In this duct there terminates an intermediate duct of the larger order but of narrow caliber, which in turn is formed (at the left) by the junction of two intermediate ducts of the smaller order. Note how flat their cells! The cells of the secreting parts are densely filled with secretion and consequently appear to be vacuolated; nevertheless their typical character (cf. Pl. 44) is evident. Note the very small amount of interstitial tissue. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Section from a **Submaxillary Salivary Gland.** × **80.**

General view. The mixed character of the gland is clearly shown, the serous predominating over the mucous secreting parts. The acidophile secretory ducts and the intermediate ducts of small caliber stand out clearly as in the parotid gland. The serous crescents are easily recognizable. Note that in contrast to the parotid gland the interstitial tissue is decidedly abundant. **Technique** as for *Fig. 1.*

Fig. 4. From a Section of **Submaxillary Salivary Gland.** × **250.**

The serous alveoli with their narrow lumina and small dark cells with round nuclei are in strong contrast to the mucous secreting parts which have wide lumina and large, clear cells with nuclei flattened against their bases. The crescents are small and consist of only a few cells. One intermediate duct collects secretion from both types of secreting part. **Technique** as for *Fig. 1.*

Fig. 5. Part of a Section of a **Sublingual Salivary Gland.** × **80.**

The gland has an unusual abundance of interstitial tissue rich in cells (lymphocytes). It is predominantly mucous; yet all the secreting parts are of mixed type and contain large groups of serous cells which often for some distance surround a narrow lumen of their own. Intermediate ducts are entirely lacking; nor as a rule are typical secretory ducts to be found. The preparation shows two large branches of the excretory duct (red). **Technique** as for *Fig. 1.*

Fig. 6. From a Section of a **Sublingual Salivary Gland.** × **250.**

Several tubulo-alveolar secreting parts are seen embedded in an abundant interstitial connective tissue rich in cells. Beside mucous cells in large number there are found, especially at the blind ends of the secreting parts, masses of serous cells (crescents) surrounding narrow lumina. **Technique** as for *Fig. 1.*

al = alveoli
art = artery
bd = interstitial connective tissue
bdl = lymphocytes in connective tissue
bg = blood vessels
de = large branch of excretory duct
ep = epithelium of salivary duct with basal striation
fez = fat cells
hm = crescents
l = lumen
lse = lumen of serous secreting part
lsm = lumen of mucous secreting part
lsch = lumen of intermediate duct
lspr = lumen of salivary duct
muz = mucous cells
sch = intermediate duct
serz = serous cells
spr = secretory ducts
tumu = mucous secreting part
tuse = serous secreting part
* = tangential section of an intermediate duct near its termination in the secretory duct

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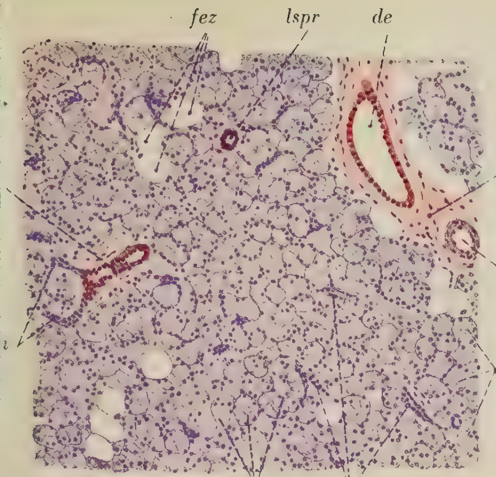
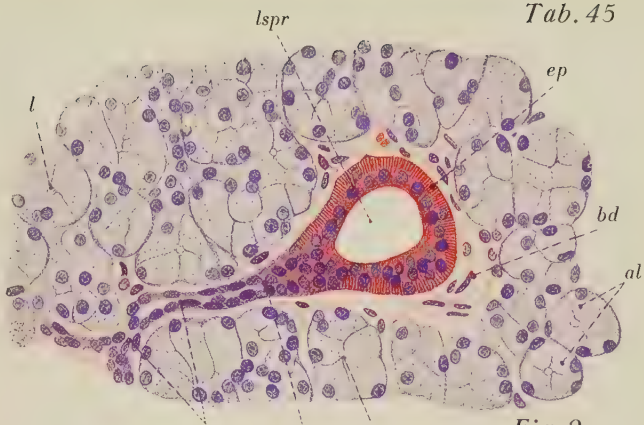
[1] All the preparations figured on this plate were derived from a man aged 28 who had been executed.

Tab. 45


fez
lspr
de
bd
art
al
al
sch
n

g. 1


lspr
ep
l
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sch
*
l

Fig. 2

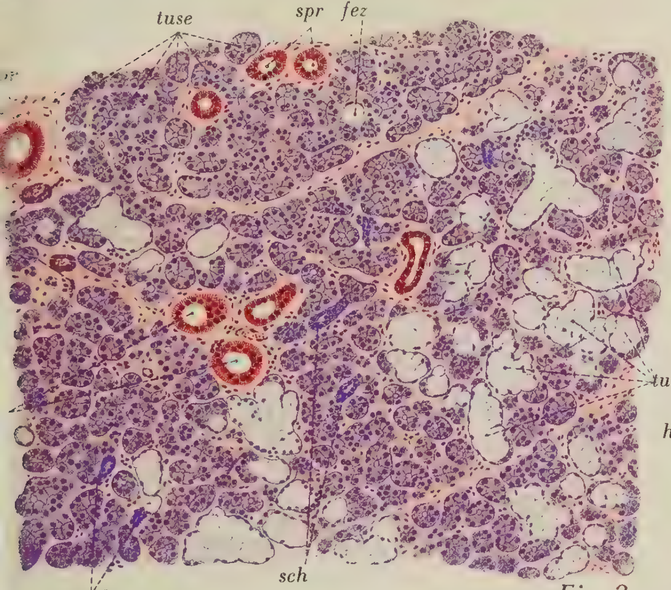

tuse
spr
fez
tumu
sch
sch

Fig. 3

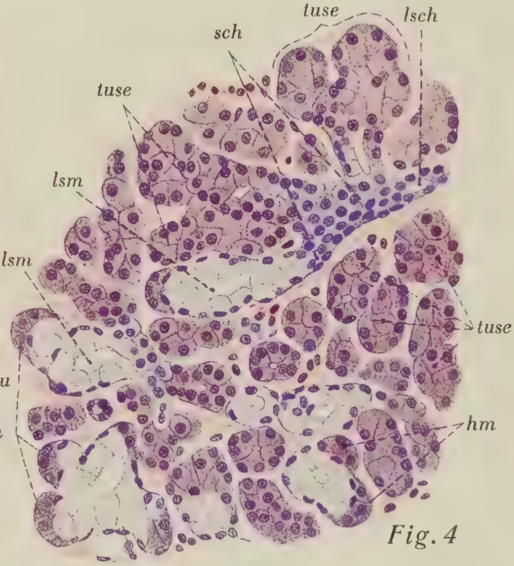

tuse
lsch
sch
tuse
lsm
lsm
tuse
hm
hm

Fig. 4

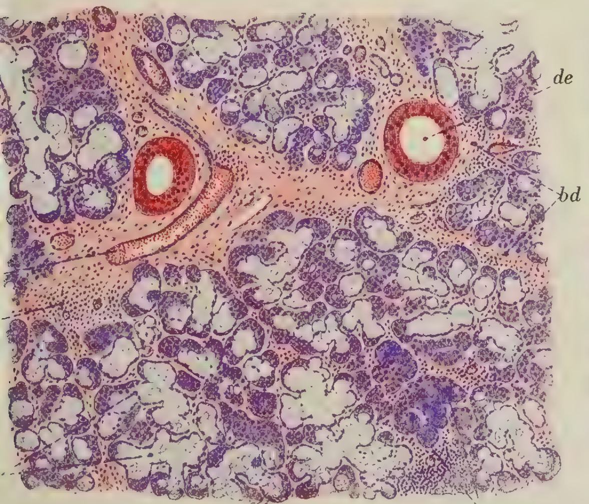
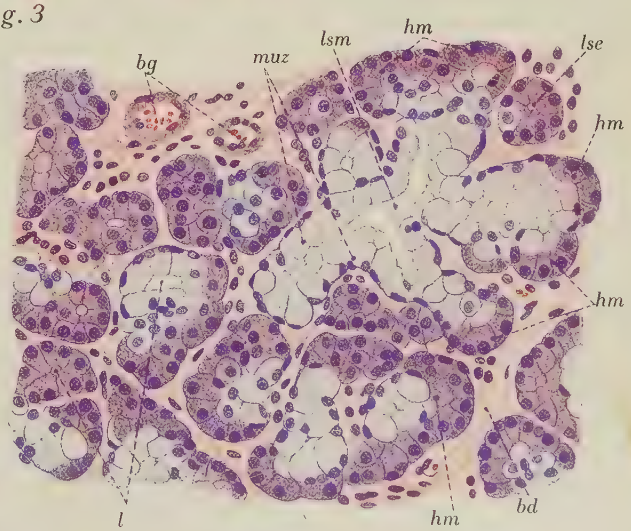


Fig. 5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hm
lse
hm
hm
l
hm
bd

Fig. 6

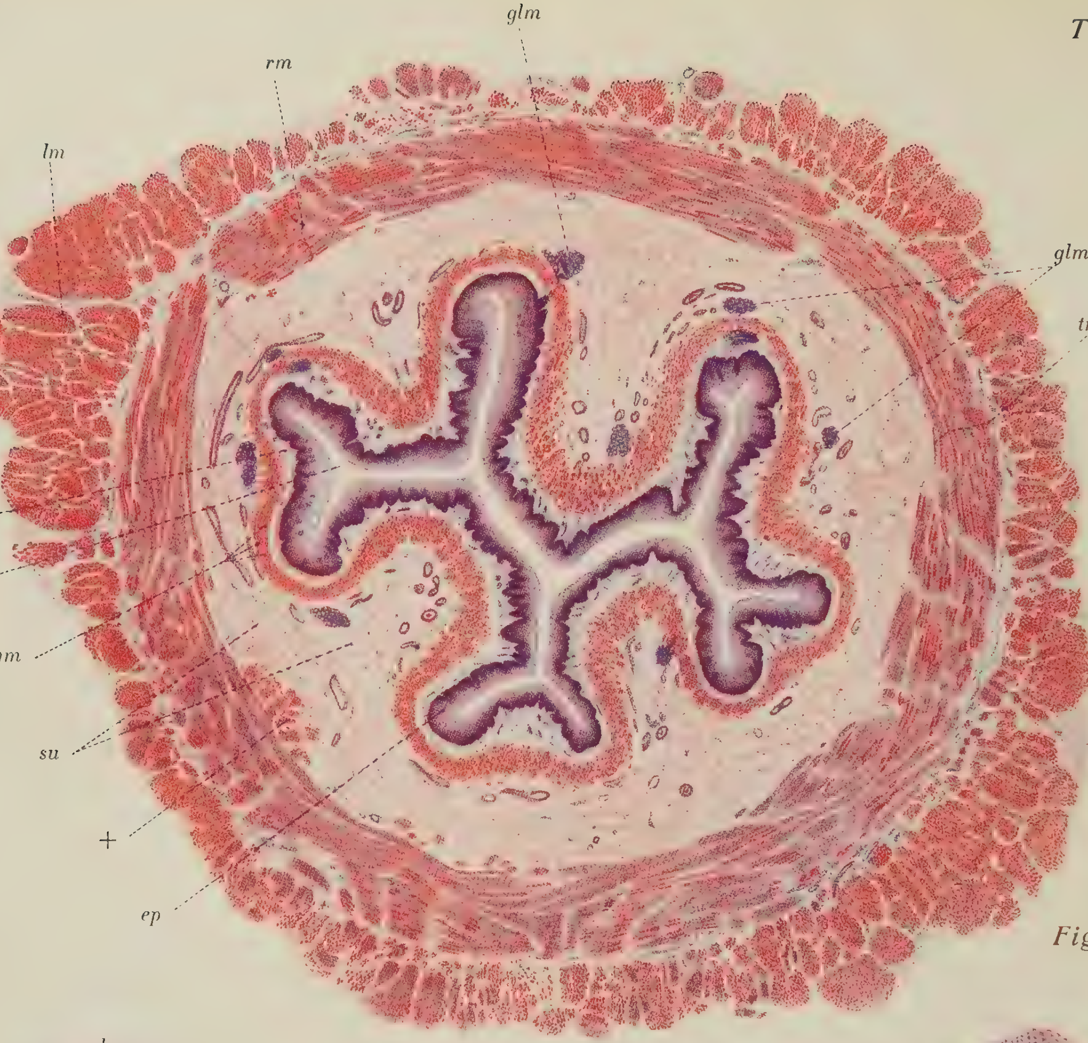

glm
rm
lm
glm
tmus
tp
l
mm
su
+
ep

Fig. 1

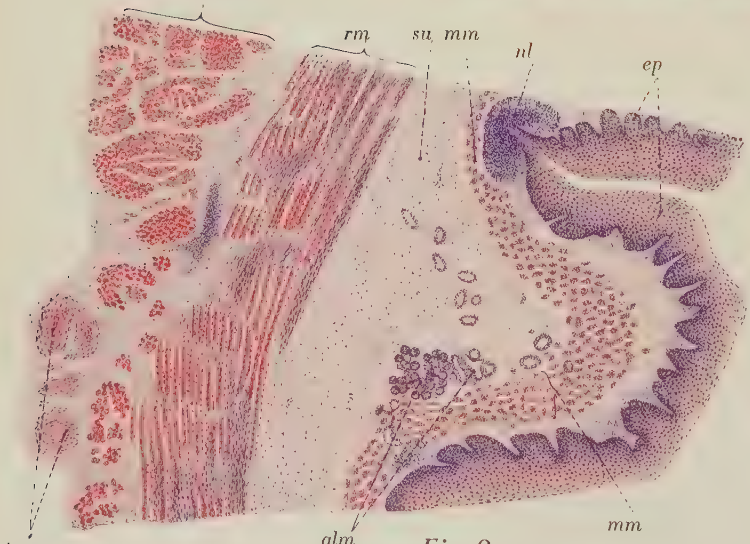

lm_1
rm
su
mm
nl
ep
glm
mm
lm_2

Fig. 2

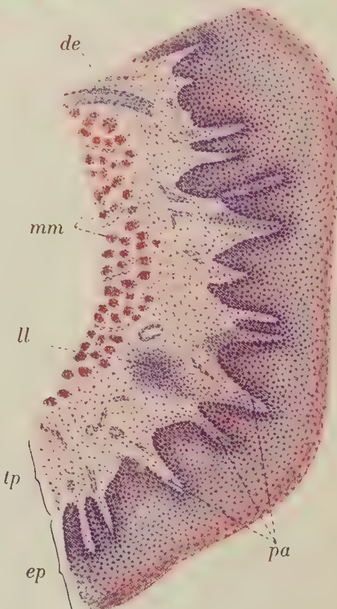

de
mm
ll
tp
ep
pa

Fig. 3

Plate 46. **Œsophagus.**

Fig. 1. Transverse Section of an **Œsophagus** (Human, aet. 28, Execution). × **11.** The preparation is from the middle third of the œsophagus where smooth muscle fibers are beginning to appear in both layers of the muscular coat along with the striated muscle. The figure gives a general view of the structure and layers in the wall of the œsophagus. At this level both muscular layers are of about equal thickness; and in spite of the low enlargement both smooth and striated muscle fibers can be distinguished, especially in the outer layer. Because the tube is empty the lumen appears narrow and the mucous membrane is thrown into deep longitudinal folds. Note the three chief layers of the œsophageal wall; mucous coat, submucous coat and muscular coat, to which an adventitial layer of loose connective tissue is added as an external wrapping. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of a Transverse Section of the Human **Œsophagus.** × **20.** Detail of *Fig. 1* showing more clearly the structure of the layers of the wall. The mucous coat consists of three sharply separated layers; namely, stratified squamous epithelium, tunica propria, and tunica muscularis mucosae. The latter is formed of longitudinal bundles of smooth muscle and is especially heavy. The narrow tunica propria sends papillae deep into the epithelium and contains accumulations of lymphocytes which may form small nodules without typical germinal centers. In the submucous coat beside blood vessels and fat cells are small glands, for the most part purely mucous. (Here, as also in *Fig. 1*, the mucus has become stained.) The muscular coat shows plainly its composition from inner circular and outer longitudinal muscular layers and also the mixture of the two types of muscle. **Technique** and source as for *Fig. 1.*

Fig. 3. Mucous Coat of the Human **Œsophagus.** × **40.** The figure illustrates the structure of the mucous coat in greater detail than does *Fig. 2.* In spite of its stoutness the tunica muscularis mucosae is not a compact layer but consists of single bundles sharply separated and running longitudinally. **Technique** etc. as for *Fig. 1.*

de = excretory duct of gland
ep = epithelium
glm = mucous glands
l = lumen
ll = accumulations of lymphocytes
lm = longitudinal layer of muscular coat
lm_1 = striated elements of the longitudinal layer
lm_2 = smooth muscle of the same layer
mm = tunica muscularis mucosae

nl = lymph nodule
pa = papillae
rm = circular layer of the muscular coat
su = submucous coat
tmus = muscular coat
tp = tunica propria
+ = isolated bundles of inner longitudinal muscle (variation)

Plate 47. **Stomach I.**

Fig. 1. From a Section Perpendicular to the **Wall of the Stomach, Pyloric Region** (**Human,** aet. 28. Execution). × **25.**

General view of the coats of the stomach wall. Above is the mucous coat with two solitary lymph nodules; it is separated from the submucosa by a relatively thick tunica muscularis mucosae of several irregular layers. The submucosa consists of loose connective tissue and seems to contain only adipose tissue and relatively large blood vessels. The muscular coat, below, is thick in the pyloric region of the stomach and shows inner circular and outer longitudinal layers. **Technique:** Müller's fluid, Celloidin. Haematoxylin-eosin.

Fig. 2. From a Section Perpendicular to the **Mucous Membrane of the Fundus of the Stomach** (Human, aet. 22. Execution). × **55.**

General view of the structure of the mucous membrane. Above is the surface epithelium dipping down into the relatively wide and shallow gastric crypts. The gastric glands occupy the lower two thirds of the mucous membrane but because of the slightly curved courses they follow are not often cut from end to end. They reach nearly to the muscularis mucosae which here appears quite thin and is formed of but one layer. The tunica propria consists of connective tissue rich in cells among which the abundance of small lymphoid elements is especially striking near the walls of the crypts. Fine scattered bundles of muscle from the muscularis mucosae turn upward among the glands. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 3. **Glandulae Gastricae Propriae** (Human). × **90.**

The gland above is bifurcated toward its fundus while the two below are sharply bent near their fundi; with them is part of a third gland. Because of their red staining the parietal cells stand out distinctly, they are abundant in the necks of the glands, less so in the bodies and rare or lacking in the fundi. **Technique** and source as for *Fig. 2.*

Fig. 4. **Transition from Gastric Crypt to Fundus Gland.** × **500.**

The crypt is lined by a relatively high columnar epithelium (see also *Fig. 7*), all the cells of which appear to be alike; its lumen is wide. The lumen of the gland is narrow; its epithelium consists partly of relatively small, low columnar cells (chief cells) which are but slightly oxyphile. The remaining cells are large and irregularly spherical; their cytoplasm is granular and is stained a vivid red by the eosin. Note the round lymphoid cells of the tunica propria. **Technique** as for *Figs. 2 and 3.*

Figs. 5 and 6. **Glandulae Gastricae Propriae** (Human). × **300.**

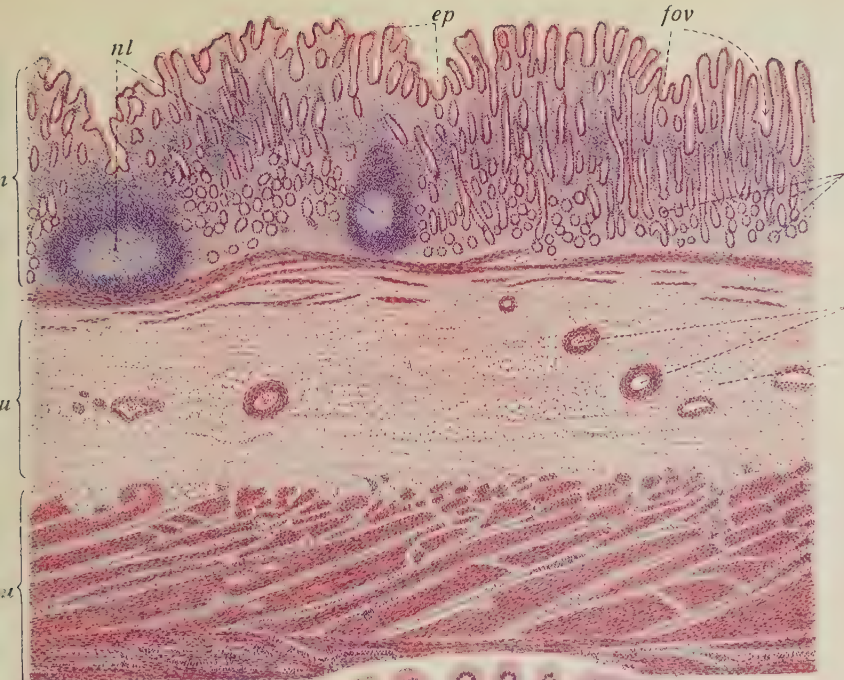
Fig. 5 shows part of a gland cut longitudinally, *Fig. 6* shows cross sections of glands. The distinction between chief and parietal cells is made clear by the difference in staining, the chief cells being bluish-violet and the parietal cells an intense red. **Technique** etc. as for *Figs. 2—4.*

Fig. 7. Transverse Section through a Human **Gastric Crypt.** × **550.**

There is seen the wide lumen lined by long columnar cells which are secreting mucus at their free ends; many of them contain large mucous vacuoles. The nuclei lie toward the bases of the cells. The epithelium rests upon a very distinct basal membrane of connective tissue. **Technique:** Salt solution saturated with sublimate. Paraffine. Haematoxylin-eosin.

bg = blood vessels
bd = connective tissue
bk = nuclei of connective tissue
btp = connective tissue of tunica propria
bz = parietal cells
cogl = neck of gland
cpgl = body of gland
ep = epithelium
fe = adipose tissue
fg = fundus of gland
fov = gastric crypts
gl = glands
glgp = gastric glands proper
glpy = pyloric glands

hz = chief cells
l = lumen of gland
lu = lumen of gastric crypt
mf = smooth muscle in the tunica propria
mm = muscularis mucosae
mp = membrana propria
mu = muscular coat
muc = mucus
nl = lymph nodules
su = submucosa
tm = mucous coat
ztp = cells of the tunica propria
* = short branches of the lumen


ep
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nl
glpy
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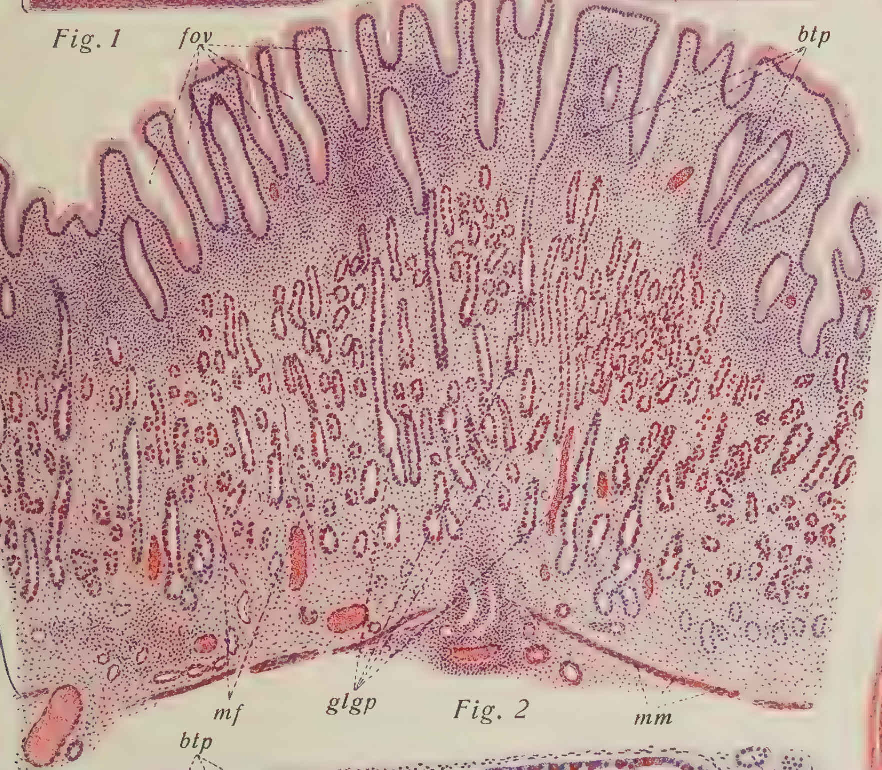
fe

Fig. 1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mf
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Fig. 2

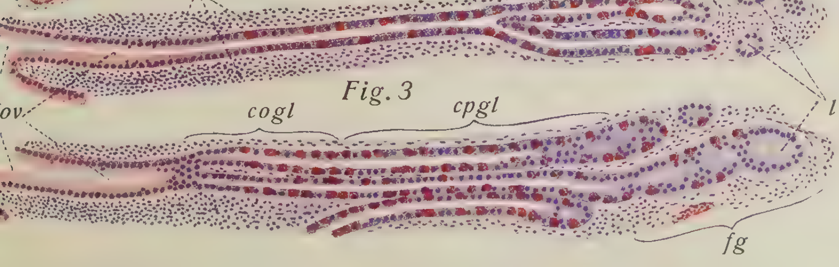
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Fig. 3

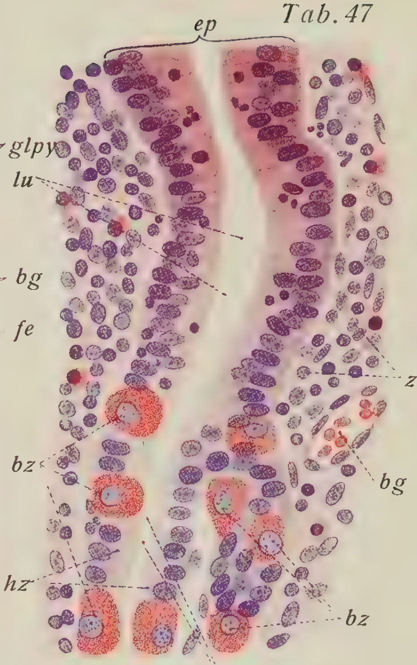
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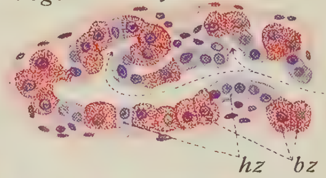
Fig. 4



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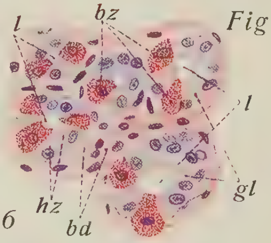
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Fig. 6

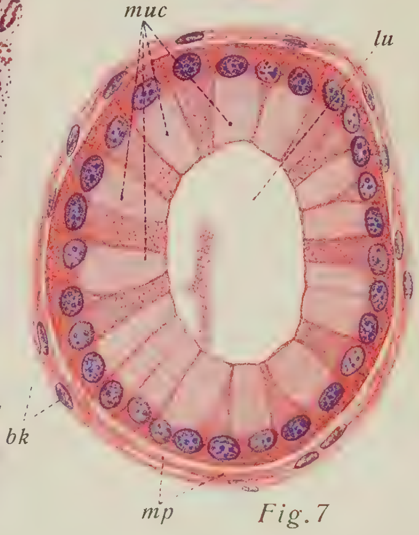

Fig. 7

Tab. 48

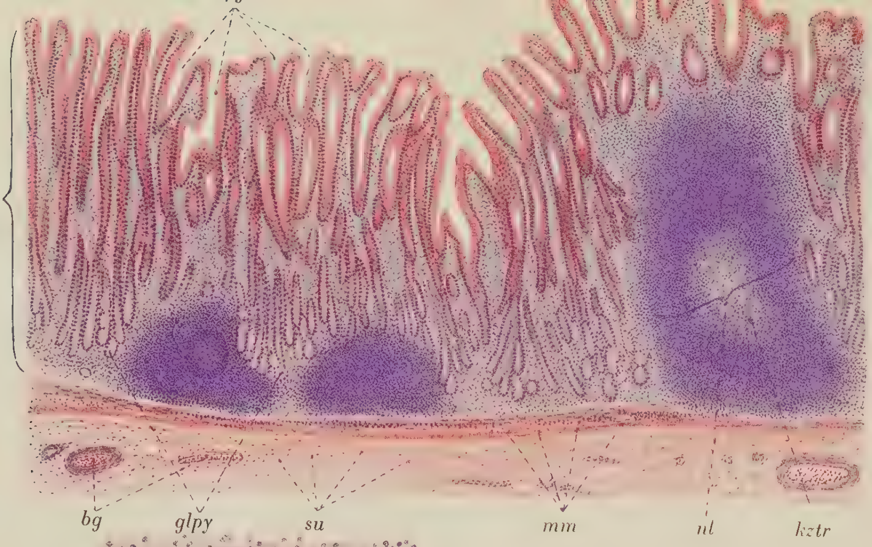
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Fig. 1

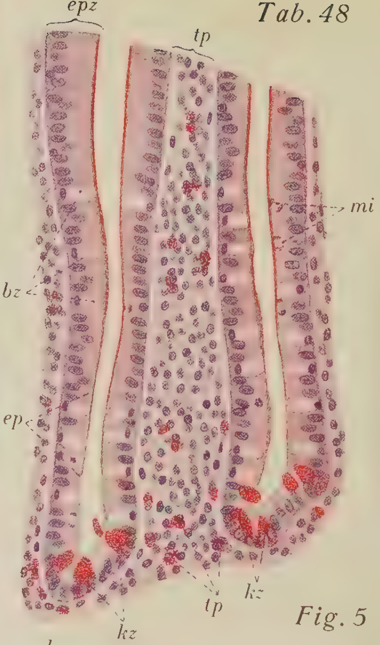
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Fig. 5

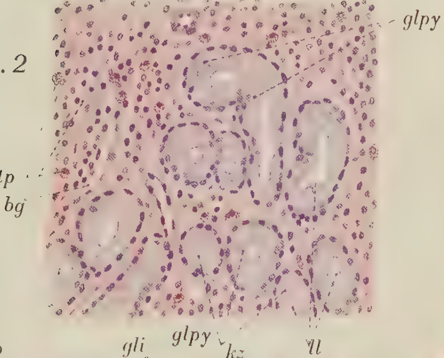
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Fig. 2

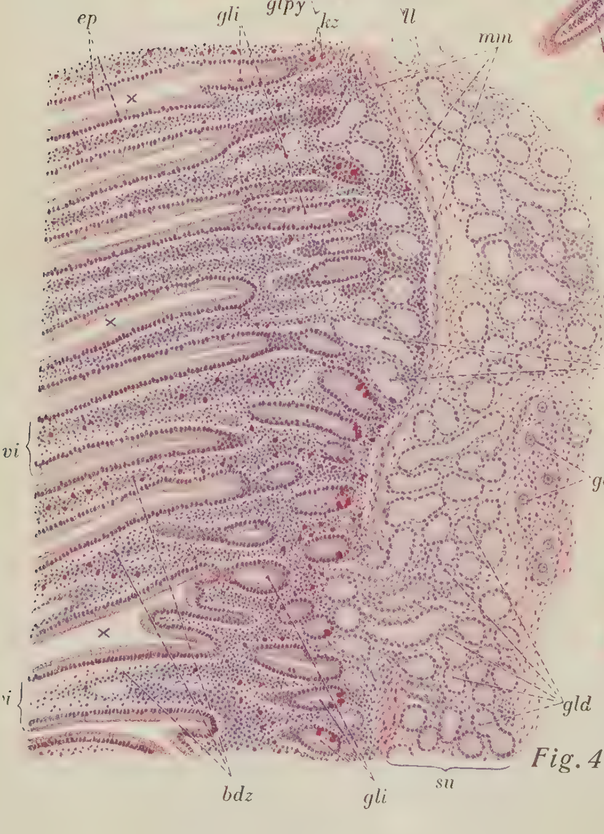
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Fig. 4

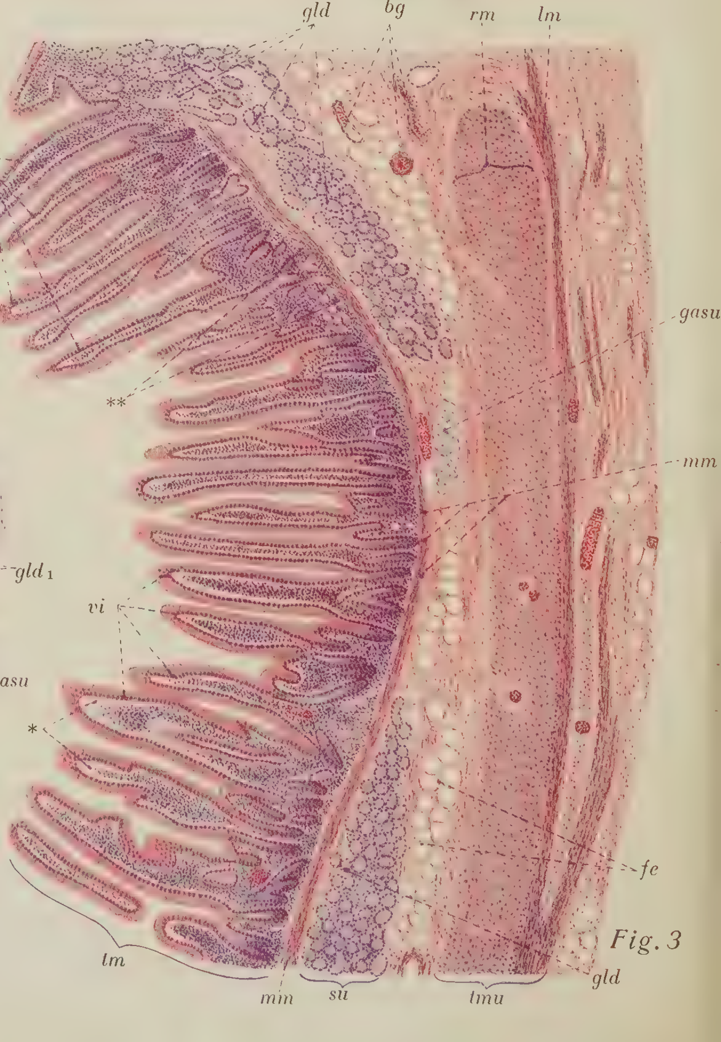
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Fig. 3

Plate 48. **Stomach II, Duodenum.**

Fig. 1. From a Section Perpendicular to the Mucous Membrane of the **Pyloric Region of the Stomach** (Human, aet. 24. Execution). × **50.**

The figure shows the typical character of the pyloric mucous membrane which is somewhat thinner than that of the main part of the stomach; however the crypts are conspicuously deeper (and for the most part considerably narrower) occupying more than half of the thickness of the membrane. Short, branched glands with sharply bent ends and formed of but one special type of cell open into the crypts. The pyloric mucous membrane contains numerous solitary lymph follicles which — as in all other parts of the stomach — are situated in the tunica propria; the figure shows two follicles cut tangentially and one cut through the middle. On the side of the submucosa the mucous membrane is bounded by a strong tunica muscularis mucosae of several layers of smooth muscle. **Technique:** Zenker's fluid, Celloidin, Haematoxylin-eosin.

Fig. 2. Part of a Section Perpendicular to the Pyloric Mucous Membrane: **Pyloric Glands** (Human, aet. 21. Execution). × **180.**

There are seen sections of the pyloric glands the cells of which recall mucous cells. Because they are so twisted the pyloric glands are cut at various angles. Between the glands is an abundant interstitial connective tissue with eosinophilic leucocytes. **Technique:** Picro-sublimate. Celloidin. Haematoxylin-eosin.

Fig. 3. Part of a Longitudinal Section of the **Pars Superior Duodeni** (Human, aet. 22. Execution). × **50.**

An almost typical picture of the small intestine with long, broad villi. In the tunica submucosa are the duodenal glands of Brunner, also adipose tissue and a ganglion of the submucous plexus. Parts of the glands of Brunner with their ducts break through the tunica muscularis mucosae and are seen alongside the glands of Lieberkühn. The connective tissue axis of the villus has in many places (*) withdrawn from the epithelial tube (artefact). **Technique:** Potassium bichromate—formol. Celloidin. Haematoxylin-eosin.

Fig. 4. **Glandulae Duodenales** (Human). × **100.**

The figure shows most of the mucous membrane and submucous coat from a section perpendicular to the surface of the upper part of the duodenum. The disposition of the glands of Brunner is clearly apparent. They lie chiefly within the submucous coat, but considerable parts of them penetrate the tunica muscularis mucosae along with the excretory ducts to lie in the tunica propria beside the glands of Lieberkühn, in the lower parts of which are the granular cells of Paneth. In the epithelium of the villi are numerous goblet cells which have their chief site here in the small intestine. Note the ganglion in the submucous coat and the abundance of cells, many of them colorless blood cells, in the tunica propria. **Technique** and source as for *Fig. 3.*

Fig. 5. **Glandulae Intestinales** (Human Duodenum). × **300.**

Two glands of Lieberkühn are seen and lying between them is the tissue of the tunica propria with its many cells. The three zones of the wall of the gland are clearly displayed: Zone 1. Ordinary columnar cells with single goblet cells form a transition to the epithelium of the villus. Zone 2. The epithelium contains mitoses for the replacement of the cells which die as a result of becoming goblet cells. Zone 3. Base of the gland containing granular cells of Paneth.

bdz = connective-tissue axes of villi
bg = blood vessels
bz = goblet cells
ep = epithelium of Lieberkühn's glands *(Fig. 5)*, or of villi *(Fig. 4)*
epz = epithelium of villus
fe = adipose tissue
fg = gastric crypts
gasu = ganglion submucosum
gld = Brunner's glands
gld_1 = Brunner's glands in tunica propria
gli = Lieberkühn's glands
glpy = pyloric glands
kz = granular cells of Paneth
kztr = germinal center of lymph nodule
ll = lumina
lm = layer of longitudinal muscle
mi = mitoses
mm = tunica muscularis mucosae
nl = solitary lymph nodule.
rm = longitudinal muscle
su = tunica submucosa
tm = tunica mucosa
tmu = tunica muscularis
tp = tunica propria
vi = villi
* = artefact caused by retraction of contents of villus
** = parts of Brunner's glands in the tunica propria

Plate 49. **Small Intestine I.**

Fig. 1. Part of a Longitudinal Section from the **Jejunum** (Human, aet. 28. Execution). × **17.** General view of the structure of the small intestine. The figure shows a section of the entire thickness of the intestinal wall with all its layers. Two plicae circulares (Kerkringi) thickly covered with villi are cut across. Large veins lie in the tunica submucosa which projects into the circular folds. A lymph nodule is seen in the mucous membrane of the lower fold. **Technique:** Absolute alcohol. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of a Section Perpendicular to the Mucous Membrane of the **Small Intestine** (Human, aet. 28. Execution). × **70.** Detail of the structure of the mucous membrane. There are seen longitudinal sections of four villi with their epithelial coverings, a few intestinal (Lieberkühnian) glands, which are very short in the small intestine; also the tunica muscularis mucosae with its extensions (mf) into the villi. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Section Containing a **Solitary Follicle** from the Human Small Intestine. × **75.** The figure shows a typical solitary lymph nodule of the small intestine thrust in between villi with its base breaking through the tunica muscularis mucosae and its top grown fast to the surface epithelium. In its middle is the germinal center surrounded by concentric rows of young lymphocytes which have wandered into the epithelium over the top of the follicle. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 4. Part of a Longitudinal Section through Two **Intestinal Villi** (Human. Execution). × **325.** The structure of the villi is apparent under the higher magnification; the diffuse lymphoid tissue of the tunica propria is seen, the axial lacteal (only partly cut) appears at the right in the upper villus and in the middle of the lower villus. The columnar epithelium has a cuticular border. Protoplasm, cuticular border, and connective tissue are stained yellowish green, nuclei bright red, mucus dark blue. Among the columnar cells are various stages in the formation of goblet cells. **Technique:** Flemming's solution. Paraffine. Staining for mucus with Delafield's haematoxylin. Safranin and picric acid.

bd = connective tissue of villus
bz = goblet cells
bz_1 = goblet cells fully developed
bz_2 = goblet cells in process of formation
cut = cuticular border
ep = epithelium
gli = intestinal glands
kz = germinal center
mf = muscle fibers in villi
mmu = tunica muscularis mucosae
mu = mucus

nls = solitary lymph nodule
plc = plicae circulares
su = tunica submucosa
tmu = tunica muscularis
tp = tunica propria
ve = veins
vi = villi intestinales
+ = intervals between villi
* = intestinal glands cut tangentially
* + = top of solitary follicle

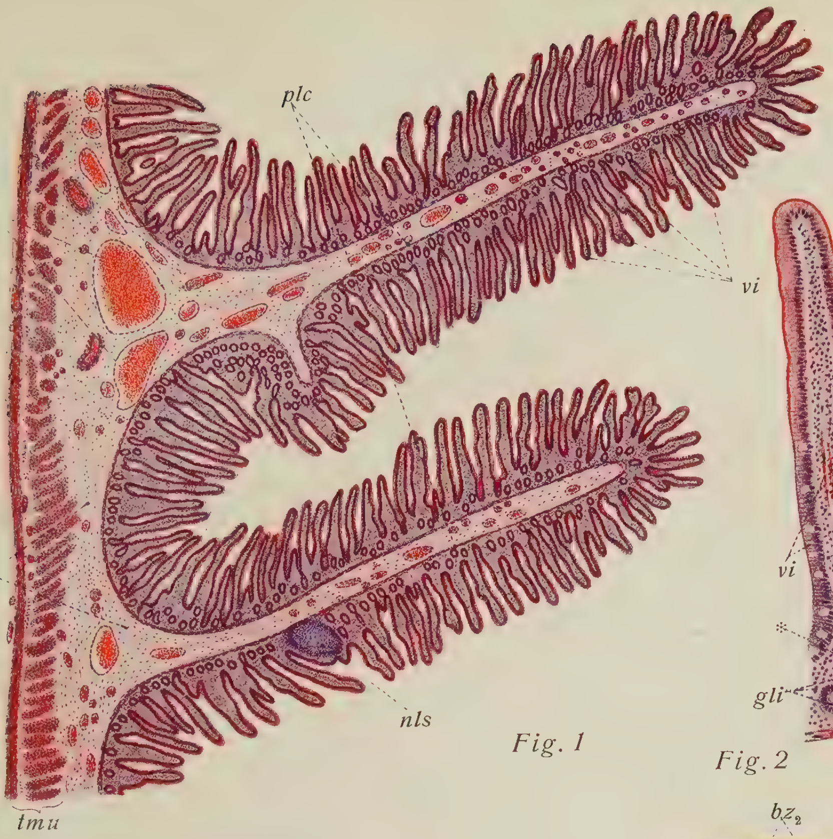
plc
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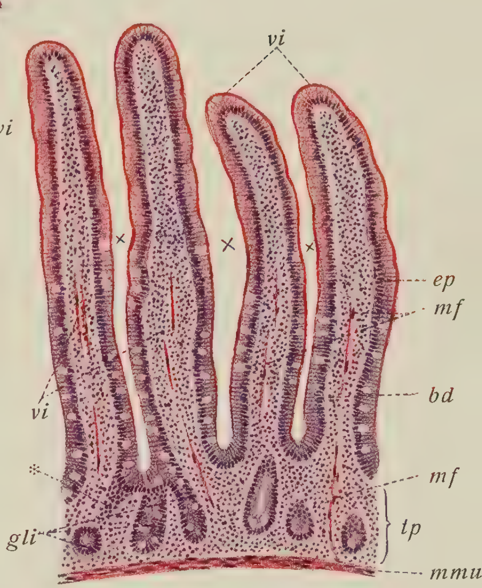
Fig. 1


vi
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mf
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bd
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Fig. 2

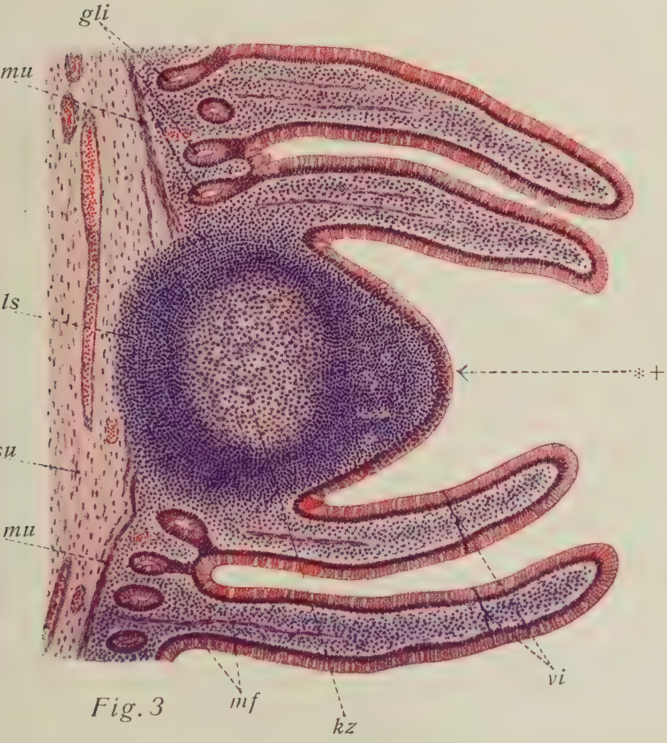
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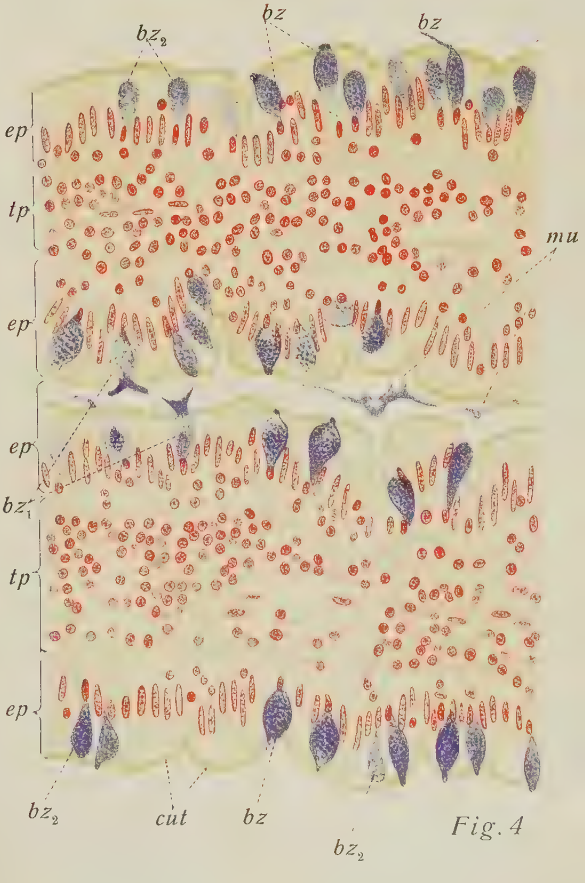
Fig. 3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mu
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bz_1
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cut
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Fig. 4

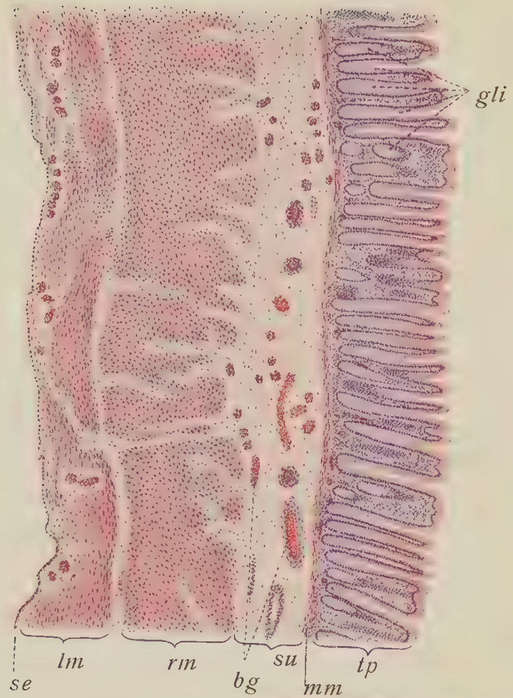
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Fig. 1

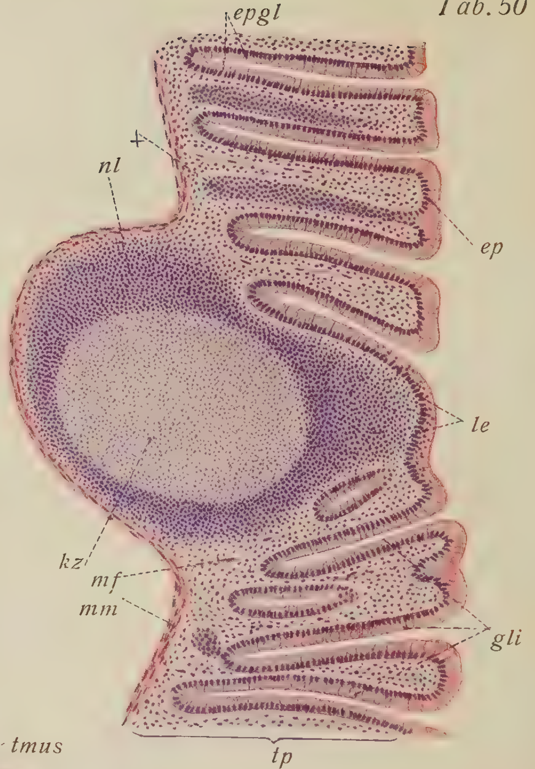
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Fig. 2

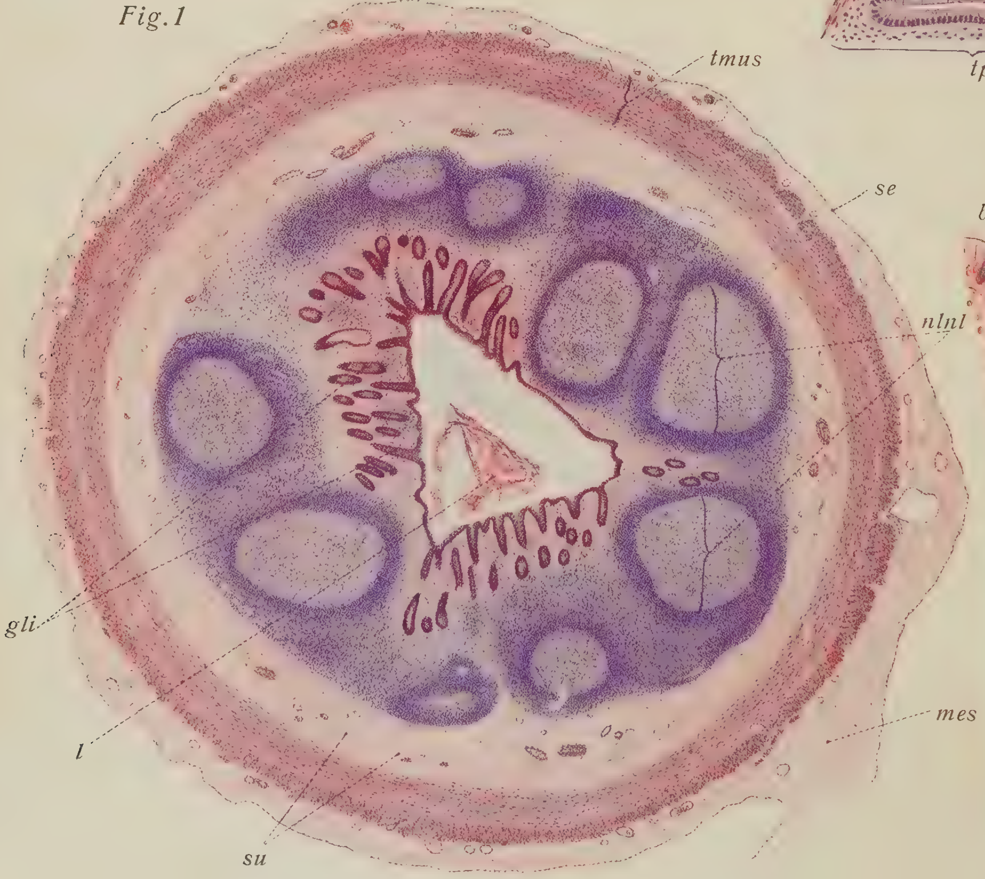
tmus
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Fig. 4

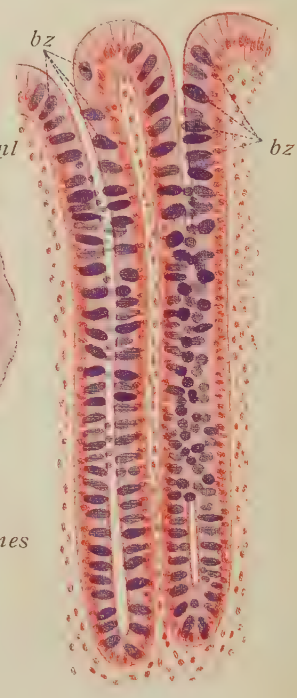

Fig. 3

Plate 50. **Large Intestine.**

Fig. 1. From a Section through the Entire **Wall of the Large Intestine.** Descending Colon (Human, aet. 21. Execution). × **33.** General view of the structure of the wall of the large intestine. On the right is the mucous membrane with rather long Lieberkühnian glands and the tunica muscularis mucosae at its base; next follows the submucosa containing adipose tissue and blood vessels. On the left is the muscular coat with its two layers, and applied to it externally is the very thin serous coat. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of a Section through the **Mucous Membrane** of the Upper Portion of the **Rectum** (Human, aet. 22. Execution). × **70.** The rectal mucous membrane agrees exactly in its structure with that of the large intestine. The figure shows the relatively long Lieberkühnian glands with abundant goblet cells and a solitary lymph nodule (with germinal center) grown fast to the surface epithelium. Beneath (on the left) is the thin muscularis mucosae from which a few fibers turn upward among the numerous cells of the tunica propria. The solitary follicle thrusts downward the muscularis mucosae into submucosa (not represented) instead of breaking through it as is usually the case. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 3. A Longitudinal Section of Two **Glands from the Human Large Intestine.** × **160.** The glands of the large intestine are longer than those of the small intestine, particularly do they increase in length toward the rectum. One gland is cut almost through its axis. The goblet cells, which in the large intestine are chiefly situated in the glands, contain mucus stained blue; in contrast to the small intestine they extend to the bottom of the glands. In the large intestine granular cells are lacking in the glands so that the latter despite their length and in contrast to those of the small intestine are, properly speaking, only crypts. **Technique:** Potassium bichromate—formol. Celloidin. Delafield's haematoxylin. Paracarmine.

Fig. 4. Transverse Section of the **Vermiform Appendix** (Human, aet. 23. Execution). × **22.** A general view of the structure of this rudimentary part of the large intestine. The abundance of lymph follicles attracts immediately attention; they are set close together, almost like the aggregated follicles of the small intestine. The main mass of these nodules lies in the submucosa which is altogether occupied by them except for a narrow zone bordering on the muscular coat. As is usual in the large intestine, goblet cells are abundant in the glands of Lieberkühn, but the glands themselves are few since they can only find room for development in the intervals between the lymph nodules. Within the narrow lumen are masses of mucous secretion. A muscular coat of two rather well developed layers surrounds the mucous and submucous coats; and upon it in turn, but separated by loose, subserous tissue, lies the serous coat. **Technique** as for *Fig. 2.*

bg = blood vessels
bz = goblet cells
ep = surface epithelium
epgl = epithelium of intestinal glands
gli = intestinal glands
kz = germinal center
l = lumen
le = wandering cells invading the epithelium
lm = layer of longitudinal muscle
mes = mesentery
mf = strands of muscle from the muscularis mucosae
mm = muscularis mucosae
nl = solitary lymph nodule
nlnl = close-set solitary nodules of the vermiform appendix
rm = layer of circular muscle
se = serosa
su = submucosa
tmus = tunica muscularis
tp = tunica propria
+ = gland cut tangentially

Plate 51. **Liver I, Gall Bladder.**

Fig. 1. **General View of the Structure of the Liver** (**Human,** aet. 22. Execution). × **70.** Two entire lobules are seen with the adjacent parts of several others. Although the boundaries of neighboring lobules are recognizable from the arrangement of the cords of cells yet a sharp demarcation is lacking over the greater part of the surface of the lobule; for the human liver, in contrast to that of many mammals, contains but little interlobular connective tissue. Only in conjunction with the interlobular vessels (interlobular veins, arteries and smaller bile ducts) does the human liver show interlobular connective tissue, and even there only in small amount. At the lower left around some of the larger vessels is one of the larger masses of such connective tissue, otherwise known as Glisson's capsule. In the center of the lobules the central veins stand out clearly and the radiating arrangement of the liver cords is easily recognized. The clear spaces between the liver cords are the so-called liver capillaries. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. **Finer Structure of a Liver Lobule.** × **340.** There is seen a part of the section pictured in *Fig. 1* containing part of a lobule with several liver cords. The liver cells forming the cords are rich in protoplasm and in some cases are binucleate. Between the cords are the liver capillaries embedded in very scanty connective tissue in which are scattered nuclei of the so-called stellate cells. Isolated fat-cells occur. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Section Perpendicular to the Wall of a **Human Gall Bladder.** × **78.** The preparation is from the part of the bladder wall which is applied to the substance of the liver and consequently has an adventitious coat of connective tissue instead of a peritoneal covering. The thin, glandless mucous membrane of the bladder forms a fold and bears a columnar epithelium. Beneath it is a rather strong layer of muscle. **Technique:** Müller's fluid—formol. Paraffine. Delafield's Haematoxylin. Eosin.

Fig. 4. **Mucous Membrane of the Gall Bladder.** × **575.** The epithelium is definitely only a single layer of rather long columnar cells. It resembles the epithelium of the intestine and often is furnished with the same kind of cuticular border. In this standard preparation (material from an operation) fine mucous droplets are present in the halves of the cells next to the lumen, and form an appearance like a cuticular border. The epithelium contains a few leucocytes. **Technique** as for *Fig. 3.*

art = interlobular arterial branches
bd = connective tissue
bdk = nuclei of the connective tissue of the tunica propria
cu = cuticular border
db = interlobular bile ducts
ep = epithelium
epk = nuclei of epithelium
er = erythrocytes
fz = hepatic fat cells
intbd(int) = interlobular connective tissue

l = leucocytes
lz_1 = mononuclear liver cells
lz_2 = binucleate liver cells
lzb = cords of liver cells
m = muscle
mugr = droplets of mucus
stz = stellate cells
tp = tunica propria
vc = central vein
vcap = capillaries
vint = interlobular veins

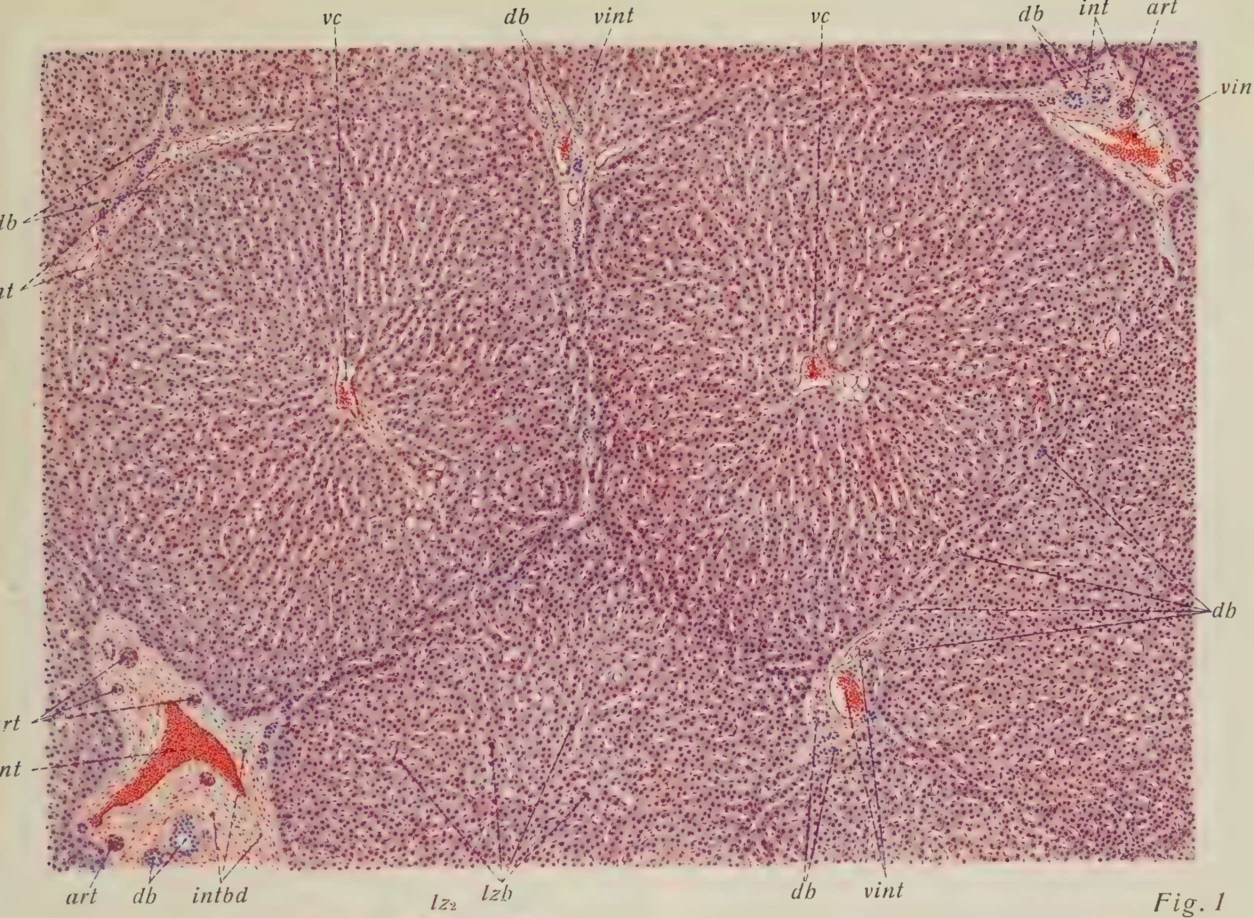
vc
db
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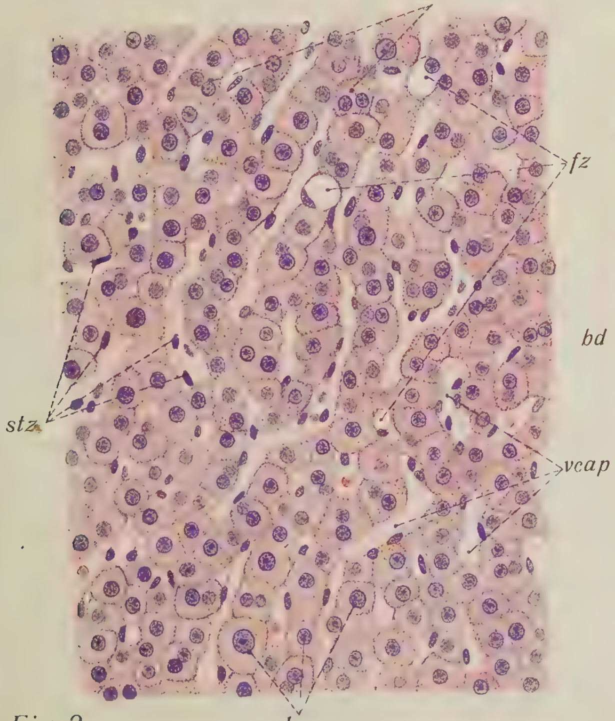
Fig. 1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lz₁

Fig. 2

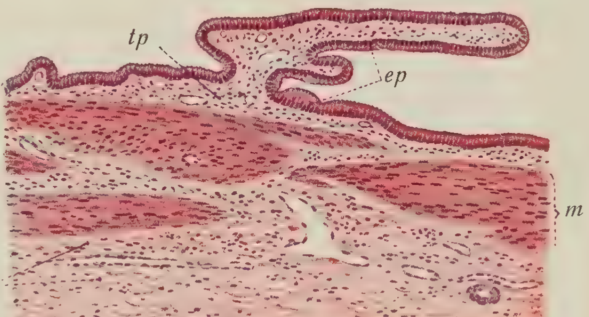

Fig. 3

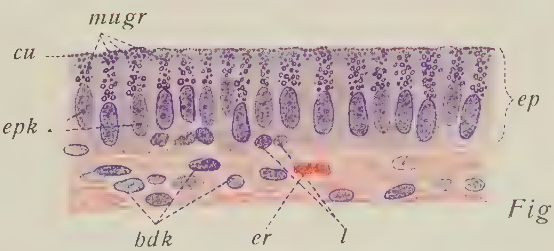
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Fig. 4

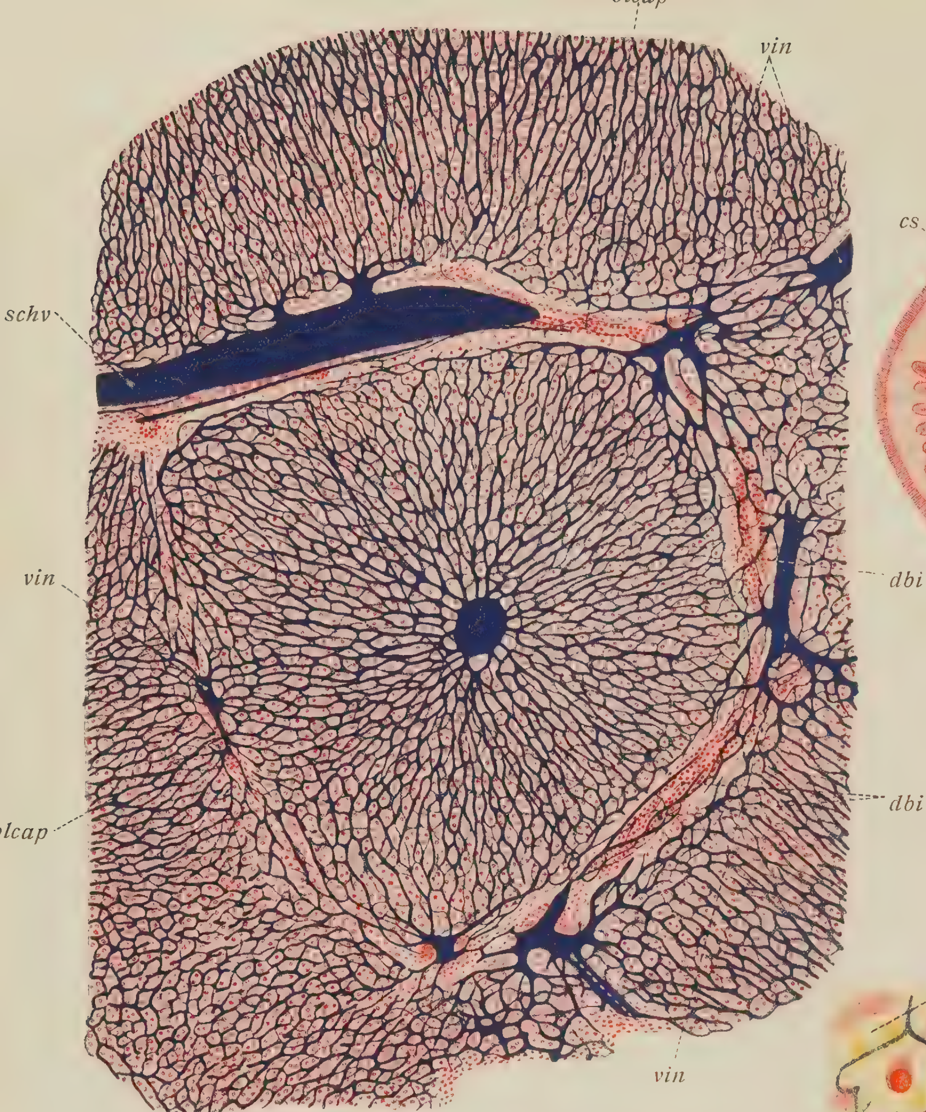
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Fig. 2

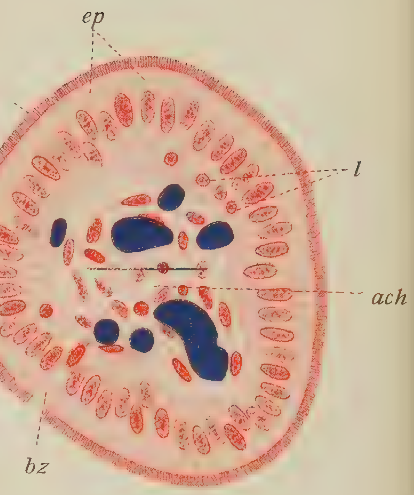
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Fig. 1

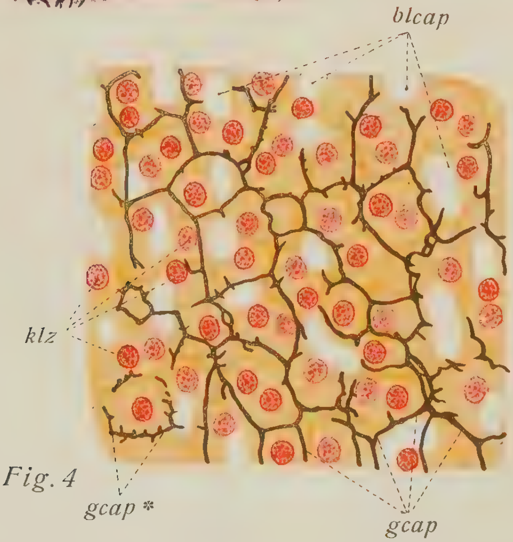
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Fig. 4

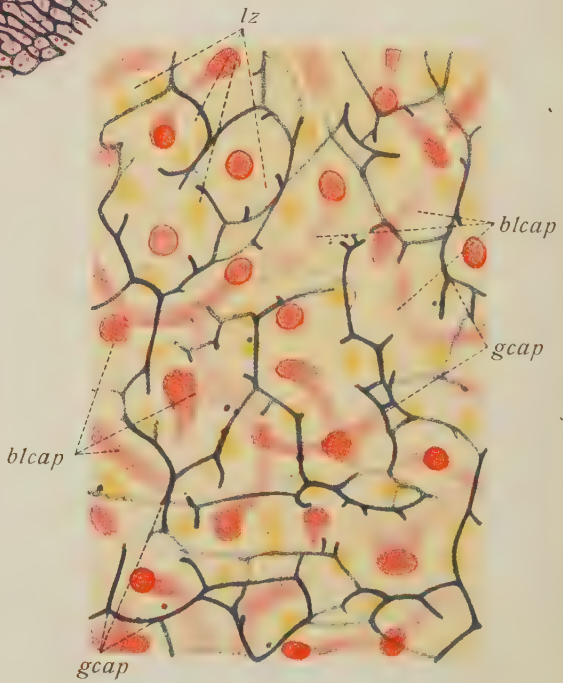

lz
blcap
gcap
blcap
gcap

Fig. 3

Plate 52. **Vessels of Liver and Small Intestine.**

Fig. 1. Transverse Section of an **Intestinal Villus (Ape).** × **500.** Externally there is seen the covering of epithelium with its distinct cuticular border. Within is the connective tissue axis with cross sections of the villar blood vessels which are well filled by the blue injection mass. At the center of the section is seen the collapsed axial lacteal. **Technique:** Injection with Berlin blue—gelatine. Müller's fluid. Borax carmine. Celloidin.

Fig. 2. Part of a Section of a **Liver Injected** Whole through the Portal Vein **(Rabbit).** × **54.** There is seen an entire hepatic lobule, easily recognized by the central vein in the middle. Around it are parts of other lobules. Injection mass blue, nuclei red. At the periphery of the lobule lie several interlobular veins, some larger, some smaller, and with the veins the accompanying interlobular branches of the bile ducts, red from the close-set epithelial nuclei. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Section through a **Doubly Injected Hepatic Lobule. (Rabbit).** × **500.** The blood capillaries have been filled with a red mass, the bile capillaries with one that is blue, the liver cells are yellow, their nuclei the same but deeper. Note the difference in caliber of the two kinds of "capillaries", the secretory canaliculi of the liver cords having but a fraction of the diameter of the blood capillaries. Also their meshes are much smaller, so that a liver cell is often surrounded on all sides by fine blue lines. **Technique:** Injection from the hepatic duct (blue) and from the portal vein (red). Absolute alcohol. Celloidin.

Fig. 4. **Bile "capillaries"** (Liver of Rabbit). × **375.** The bile canaliculi have not been made evident by injection but by Golgi's method of silver impregnation. Consequently they appear black, and not as in the injection picture (*Fig. 3*) as even tubes of very fine caliber, but as decidedly uneven and of somewhat greater diameter. In particular they show numerous small knoblike outgrowths which extend from the periphery of a cell into its interior, often nearly to the nucleus. Nuclei of the liver cells are red. **Technique:** Potassium bichromate—osmic acid. Silver nitrate. Celloidin. Reduction by hydrochinone. Alum carmine.

ach = axial lacteal
blcap = blood capillaries
bz = goblet cells in epithelium of villus
cs = cuticular border
dbi = interlobular bile ducts
ep = intestinal epithelium
gcap = bile capillaries
*gcap** = projections from the bile capillaries into the hepatic cells
klz = nuclei of hepatic cells
l = lumen
lz = hepatic cells
schv = larger interlobular vein
vin = smaller interlobular veins

Plate 53. **Small Intestine II, Liver II, Pancreas I.**

Fig. 1. Part of a Section Perpendicular to the **Wall of the Small Intestine.** Peyer's Patch (Cat). × **20.** The figure shows a section through a Peyer's patch the broader part of which, containing the germinal centers, lies in the tunica submucosa, while the inner end of each individual nodule lies in the mucous coat forming a sort of broader, lymphoid villus. **Technique:** Müller's fluid. Celloidin, Haematoxylin-eosin.

Fig. 2. Part of a **Longitudinal Section of a Villus** (Human. Small Intestine). × **280.** The epithelium is cut rather tangentially in many places and scarcely appears characteristic. On the other hand the precollagenous reticulum fibers in the connective tissue of the villus are stained black. It is seen how they form the membrana propria of the epithelium and the basal membrane of the axial lacteal. **Technique:** the Bielschowsky-Studnicka silver process.

Fig. 3. Part of a Section of an **Hepatic Lobule. Stellate Cells** (Rabbit). × **350.** The stellate cells are seen in the intervals between the large hepatic cells. Twenty-four hours before death the animal had been injected through the auricular vein with Chinese ink which being taken up by the phagocytic stellate cells causes them to appear almost black under this enlargement. **Technique:** Injection of Chinese ink into the bloodstream. Zenker's fluid. Paraffine. Alum carmine.

Fig. 4. **Stellate Cells of the Liver.** × **900.** Detail of *Fig. 3.* The hepatic cells now appear quite large and in some cases are binucleate. Between them lie the empty hepatic capillaries in the walls of which are seen the stellate cells and also the nuclei of ordinary endothelial cells. The particles of ink more or less fill the branched irregular cytosomes of the stellate cells which along with their nuclei are thus made evident. **Technique** etc. as for *Fig. 3.*

Fig. 5. Precollagenous **Reticulum Fibers** of the Human Liver. × **200.** Above in the section lies a central vein and below a bile duct with surrounding interlobular connective tissue. Within the hepatic lobule are seen the quite pale bodies of the liver cells and somewhat more clearly their nuclei. Only the precollagenous tissue formed of so-called reticulum fibers is stained quite black. **Technique:** The Bielschowsky-Studnicka silver process.

Fig. 6. Part of an Unusually Thin Section of a **Pancreatic Lobule.** (**Human,** Execution). × **500.** Three alveoli are cut, one of which passes into an intermediate duct and shows the relation between the centro-alveolar cells and the wall of the duct. The cells of the alveoli are striated at their bases; within them are fat droplets stained black, and pale secretion granules. **Technique:** Flemming's solution. Paraffine. Safranin.

axch = axial lacteal
bd = interstitial connective tissue of the pancreas
cap = capillaries
caz = centro-alveolar cells
cp = pancreatic cells
dbi = interlobular bile duct
ep = epithelium
gf = reticulum fibers of the hepatic lobule
intbd = hepatic interlobular connective tissue
k = nuclei of pancreatic cells
kend = nucleus of endothelial cell
klz = nuclei of liver cells
kstz = nucleus of stellate cell
l = lumen with centro-alveolar cells
l_1 = lumen of intermediate duct
lz = hepatic cells
mp = membrana propria
nl = noduli lymphatici aggregati
sch = intermediate duct
stz = stellate cells
talv = tubulo-alveolar secreting parts
vc = central vein
vi = intestinal villi
zsch = cells of intermediate duct
* in *fig. 1* = villus-like processes of lymph follicles
* in *fig. 2* = wall of axial lacteal cut tangentially

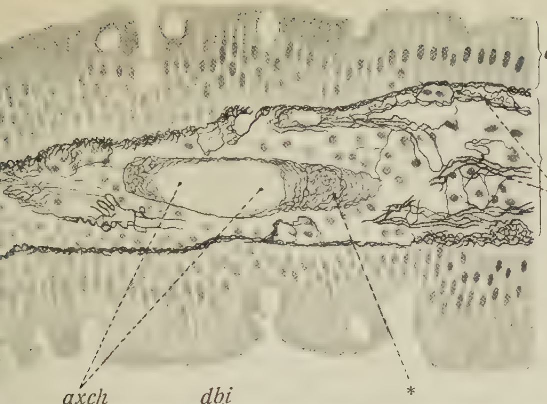

ep
tp
gf
axch
*

Fig. 2

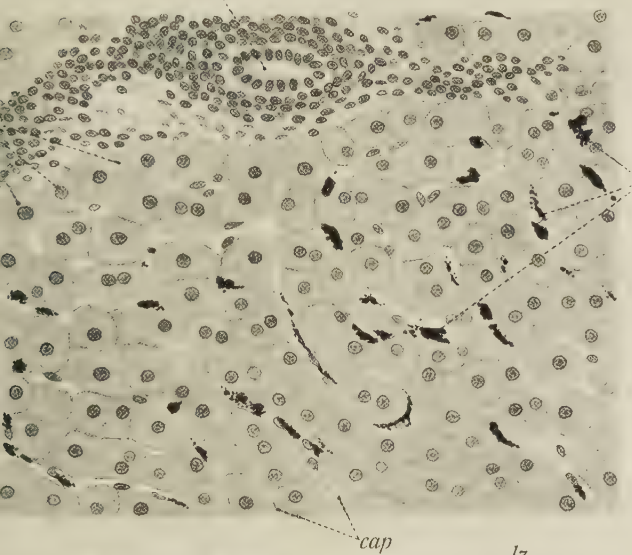
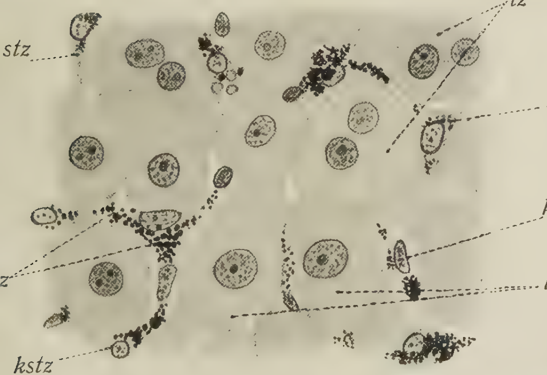


Fig. 3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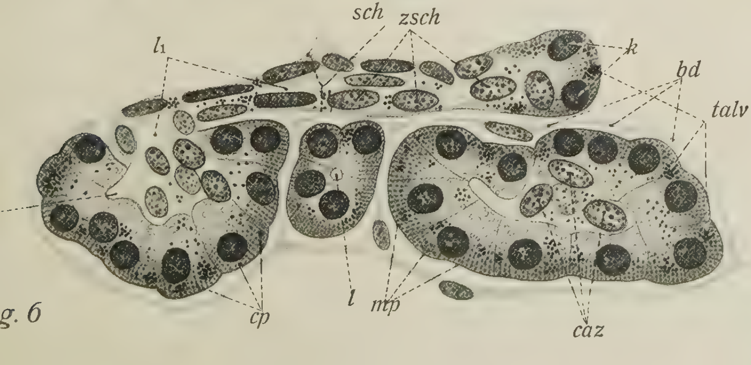
lz
stz
kend
z
lz
kstz

Fig. 4


sch
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talv
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l
mp
caz

g. 6

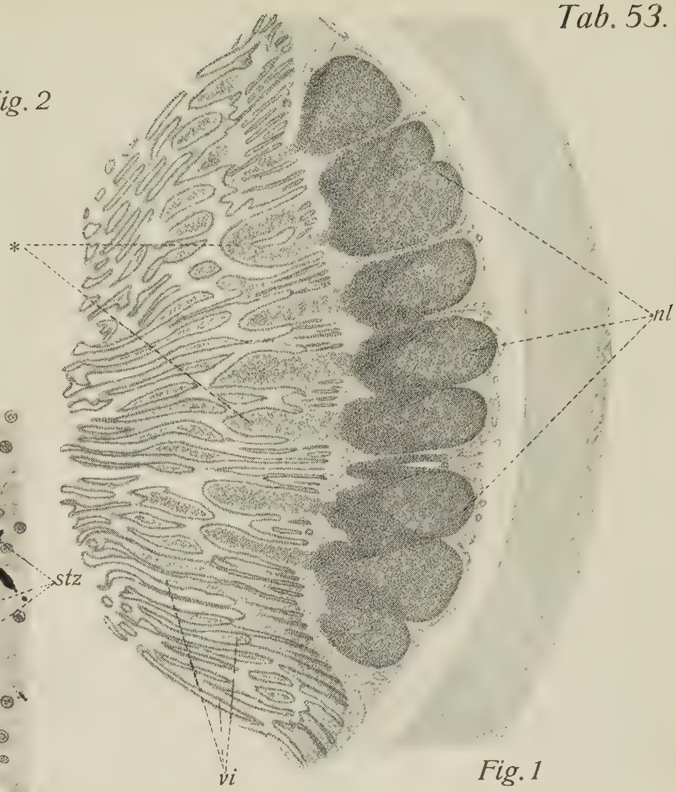


Fig. 1

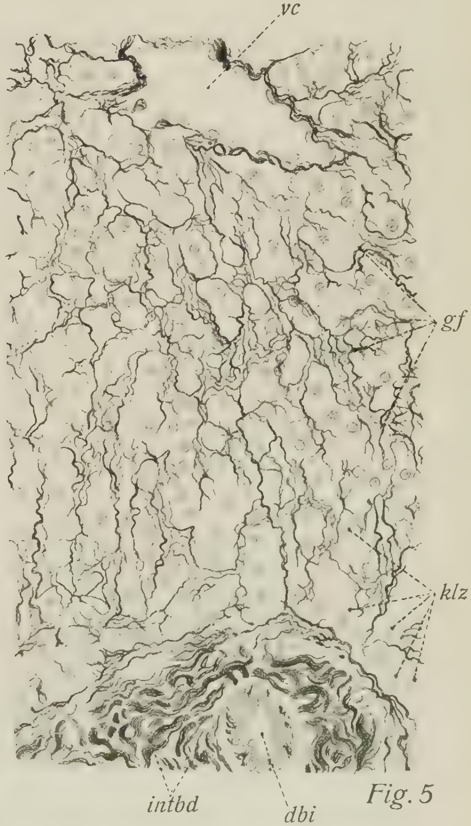
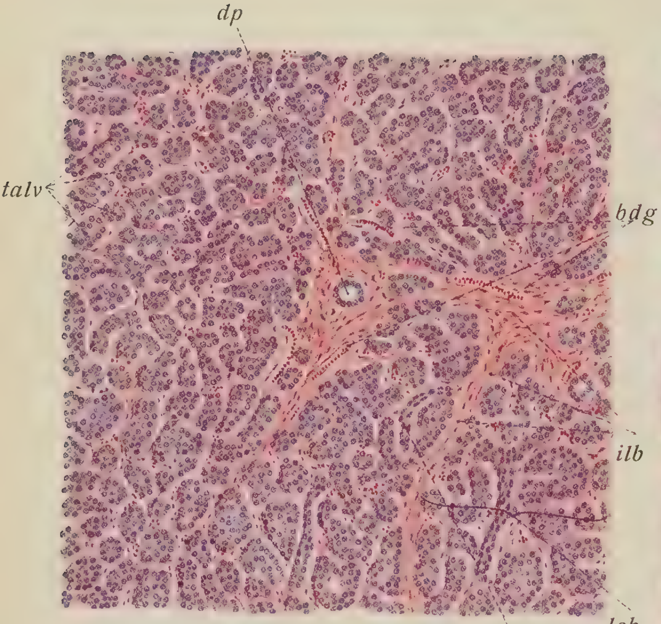

vc
gf
klz
intbd
dbi

Fig. 5


dp
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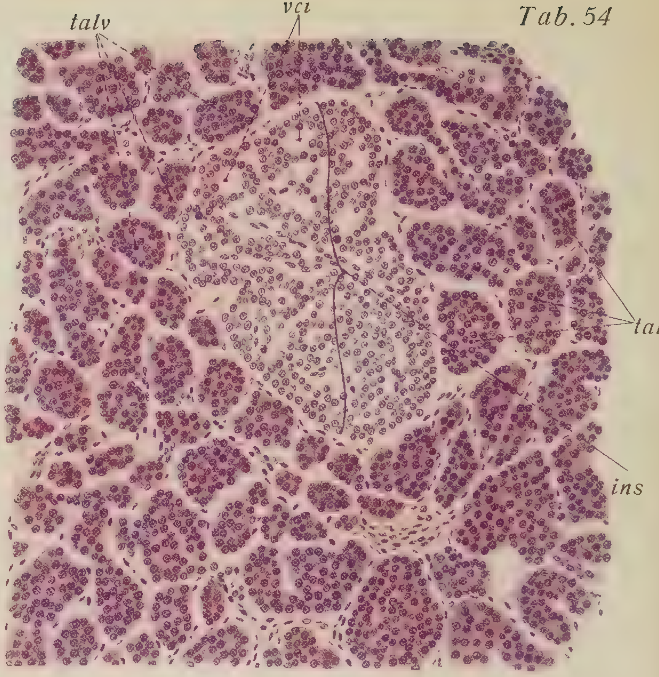
lob
sch

Fig. 1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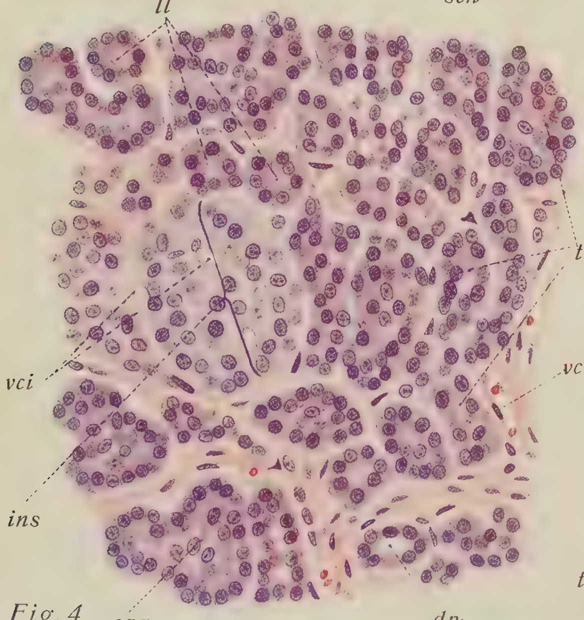
vci
talv
ins

Fig. 2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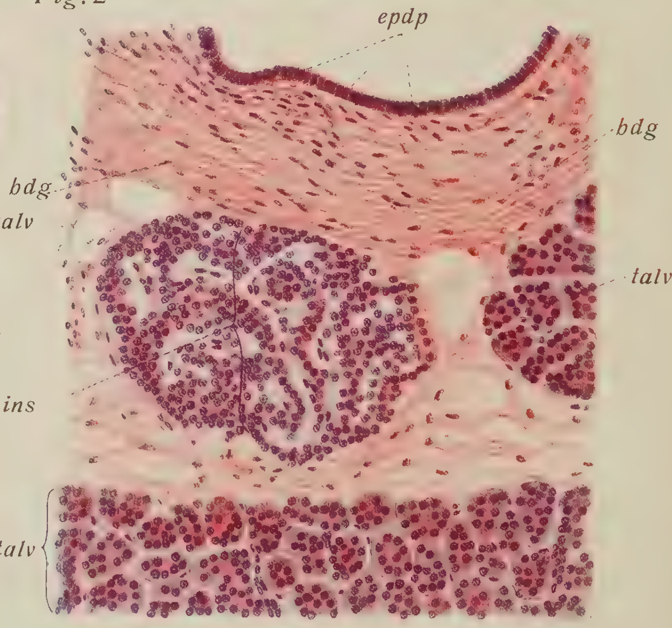
caz
dp_1

Fig. 4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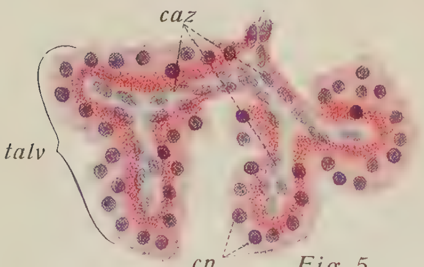
talv

Fig. 3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caz
talv
cp

Fig. 5

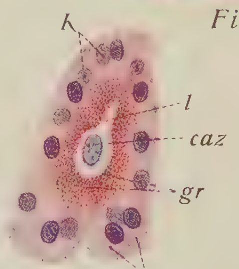


Fig. 6

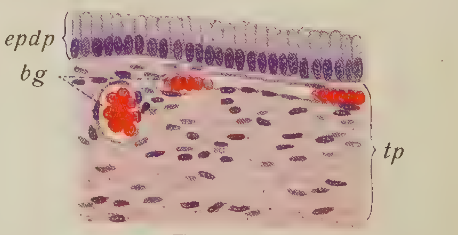


Fig. 7

Plate 54. **Pancreas II. (Principal Plate).**

Fig. 1. Part of a Section from the **Human Pancreas.** × **120.** General view. There are seen parts of several lobules, indistinctly separated from one another by interlobular connective tissue. Beside the exocrine parenchyma of the lobules a few endocrine islands are also visible. In the center surrounded by a broad layer of connective tissue is a large branch of the pancreatic duct while below and to the right is an intermediate duct. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 2. Part of a Section from the **Pancreas. (Human,** aet. 25. Execution). × **200.** Exocrine and endocrine parenchyma. There are seen numerous sections of the secreting parts which are tubulo-alveolar to purely tubular in form and which constitute the exocrine part of the gland; the lumina in most cases are occupied by centro-alveolar cells. Near the center of the figure is a large sharply defined island of Langerhans, surrounded by the exocrine parenchyma and made evident by the paleness of its cells. **Technique** as for *Fig. 1.*

Fig. 3. **A Completely Isolated Pancreatic Island.** × **200.** From a preparation similar to that of *Fig. 2.* The island is seen in the connective tissue surrounding a duct, a part of the wall of which is visible. The island is large and is separated on all sides from the exocrine parenchyma by connective tissue. Its isolated position is striking. **Technique** as for *Fig. 1.*

Fig. 4. A Small Part of a Very Thin Section of a **Human Pancreas.** × **450.** A small island is to be seen with its lightly stained endocrine cells and in its interior blood capillaries. Its demarcation from the surrounding exocrine parenchyma is by no means sharp. The lumina of the exocrine alveoli are uniformly narrow, very few of them are empty for in most cases they are occupied by the centro-alveolar cells. On the right and below is a small branch of the excretory duct. **Technique** as for *Fig. 1.*

Fig. 5. Two Tubulo-alveoli with the Connected Intermediate Duct **(Human Pancreas).** × **400.** From a very thin section. The transition from the flat cells of the wall of the intermediate duct to the centro-alveolar cells is clearly seen. **Technique** as for *Fig. 1.*

Fig. 6. A Tubulo-alveolus from a Very Thin Section of **Human Pancreas.** × **500.** In the lumen is seen a centro-alveolar cell with large flat nucleus. The secretion granules of the alveolar cells show distinctly in the zone next to the lumen. **Technique:** Potassium bichromate—formol. Paraffine. Haematoxylin-eosin.

Fig. 7. Part of a Section through the Wall of the Human **Pancreatic Duct.** × **400.** A simple columnar epithelium of rather high, palisade-like form rests upon a basis of pure connective tissue. **Technique** as for *Fig. 1.*

bg = blood vessels
bdg = connective tissue
caz = centro-alveolar cells
cp = pancreatic cells
dp = branch of the pancreatic duct
dp_1 = small branch of the excretory duct
epdp = epithelium of the pancreatic duct
gr = granules
ilb = interlobular connective tissue
ins = island of Langerhans
K = nuclei
l(ll) = lumen (lumina)
sch = intermediate duct
lob = lobule
talv = tubulo-alveoli
tp = tunica propria
vc = blood capillaries
vci = capillaries of the island

Plate 55. **Nasal Cavity.**

Fig. 1. A Section through the **Lateral** (Bony) **Nasal Wall** (Human, aet. 22. Execution). × **45.** General view of the structure of the mucous membrane of the regio respiratoria. On the left is the surface epithelium and beneath it is the thick mucous membrane with numerous vessels and glands. The deeper layer of the membrane contains fewer cells and more fibers; it reaches and passes gradually into the periosteum of the bone, the lamellae of which occupy the extreme right. **Technique:** Zenker's fluid. Decalcification in nitric acid. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of a Section Perpendicular to the Mucous Membrane of the Human **Inferior Turbinate Bone (Regio Respiratoria).** × **110.** The structure of the mucous membrane is more clearly shown than in *Fig. 1.* On the left is the high, stratified, ciliated epithelium and beneath it the tunica propria containing, especially near the epithelium, an unusual abundance of plasma and lymphoid cells. More deeply and toward the periosteum of the thin turbinate bone the number of cells is considerably diminished. Within the tunica propria are mucous glands and large, wide-open veins; farther to the right is the turbinate bone. **Technique** and source as for *Fig. 1.*

Fig. 3. Superficial Layer of the **Mucous Membrane of the Regio Respiratoria** (Human). × **200.** The stratified, ciliated epithelium with a few goblet cells stands out clearly as does also the abundance of cells in the tunica propria. An excretory duct opens toward the right, its simple epithelium passes gradually into the stratified epithelium of the surface. **Technique** and source as for *Figs. 1 and 2.*

Fig. 4. **Mucous Membrane of the Regio Olfactoria** (Human, Region of the Superior Turbinate Bone). × **160.** Above is the stratified columnar epithelium, not so high as that of the respiratory region and without cilia. On its surface lies a film of secretion (see *Fig. 5*) from the olfactory glands which are visible in the tunica propria as small serous glands with few branches. Through the tunica propria with its many cells runs a rather stout bundle of the non-medullated fibers of the olfactory nerve. **Technique** and source as for *Figs. 1—3.*

Fig. 5. From the Mucous Membrane of the **Regio Olfactoria.** × **430.** Part of the preparation pictured in *Fig. 4.* Only the epithelium and adjacent part of the tunica propria are to be seen. The former appears as a columnar epithelium of several layers and without cilia. The conical projections from the epithelium are either olfactory hairs or particles of the secretion which lies upon them like a membrane. The olfactory cells as such cannot be recognized (cf. Pl. 87 *Fig. 1*). A few branched pigmented figures (pigment cells ?) are seen in the epithelium; also the opening of a duct from an olfactory gland and close by in the tunica propria a part of a gland. **Technique** and source as for *Figs. 1 —4.*

bg = blood vessels
du = excretory duct
*du** = duct cut tangentially
ep = epithelium
gl = glands of the respiratory region
glo = glands of the olfactory region
ke_1 = vein
ke_2 = nuclei of basal cells
kn = bone
nol = branch of olfactory nerve

p = pigmented figures within epithelium
tp = tunica propria
tp_1 = fibrous layer of the propria passing into periosteum
ve = veins
ve (Fig. 5, below) = nuclei of olfactory cells
* = So-called olfactory cones (olfactory hairs)
+ = Secretion membrane of the olfactory epithelium

Tab. 55

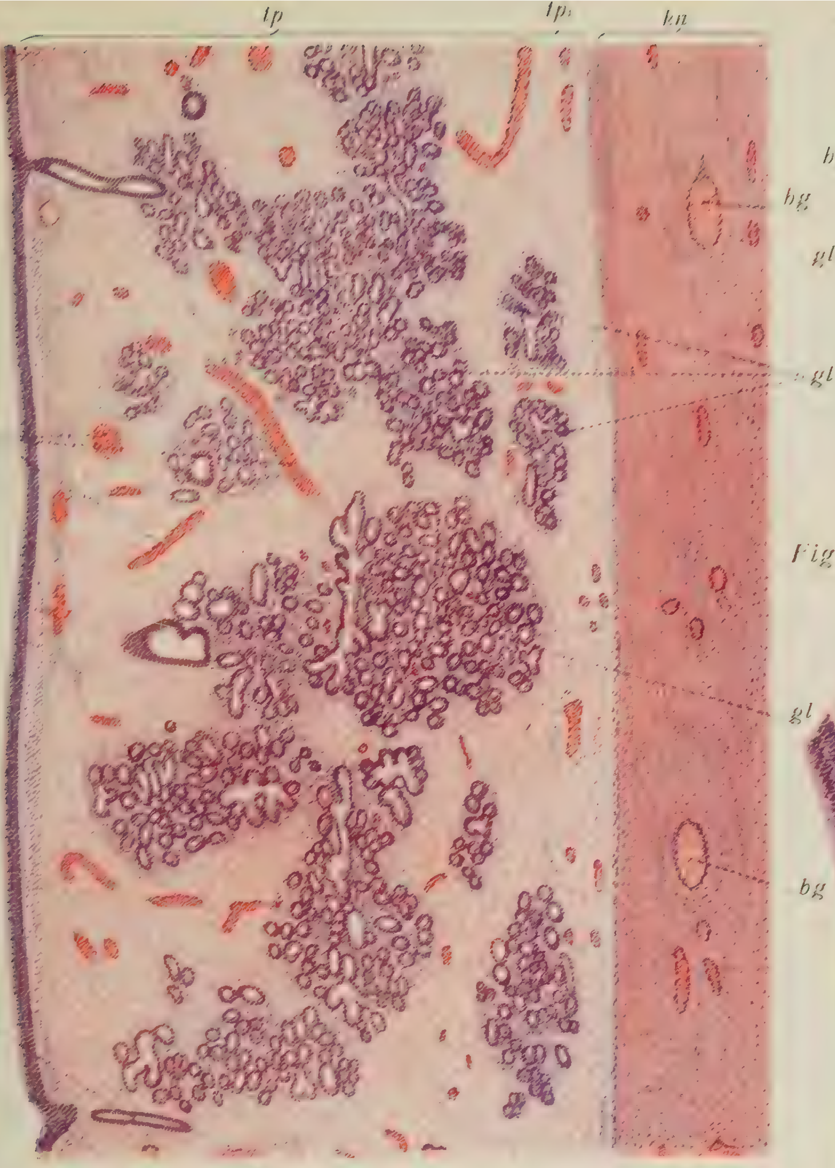
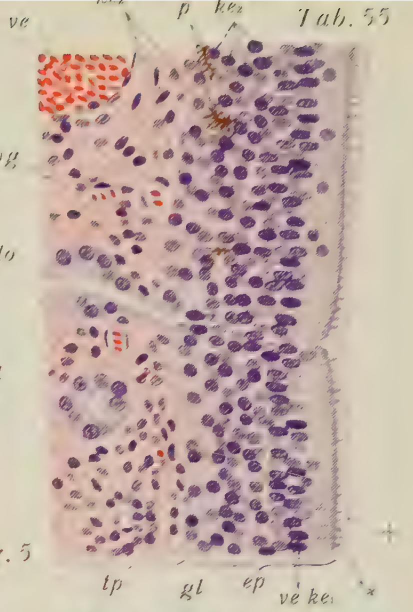

tp
tp_1
kn
bg
gl
gl
bg

Fig. 1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tp
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ve
ke_1
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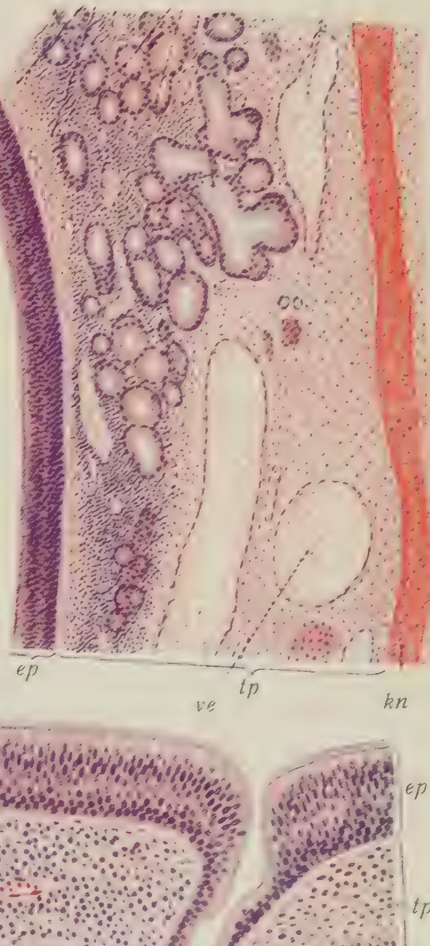
*

Fig. 5



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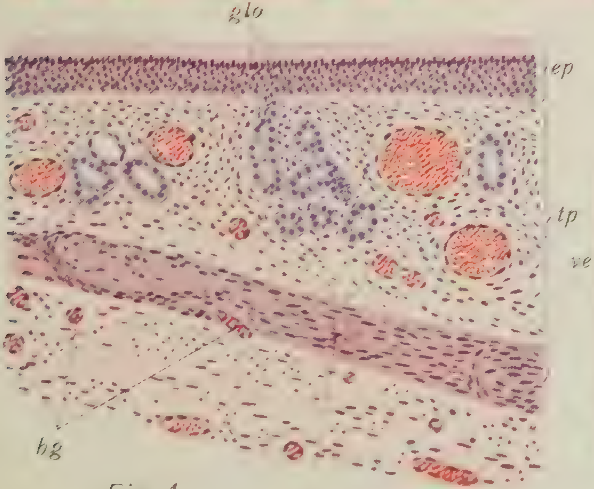
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Fig. 4

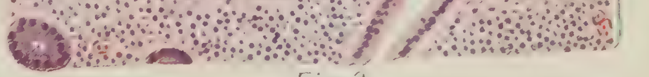
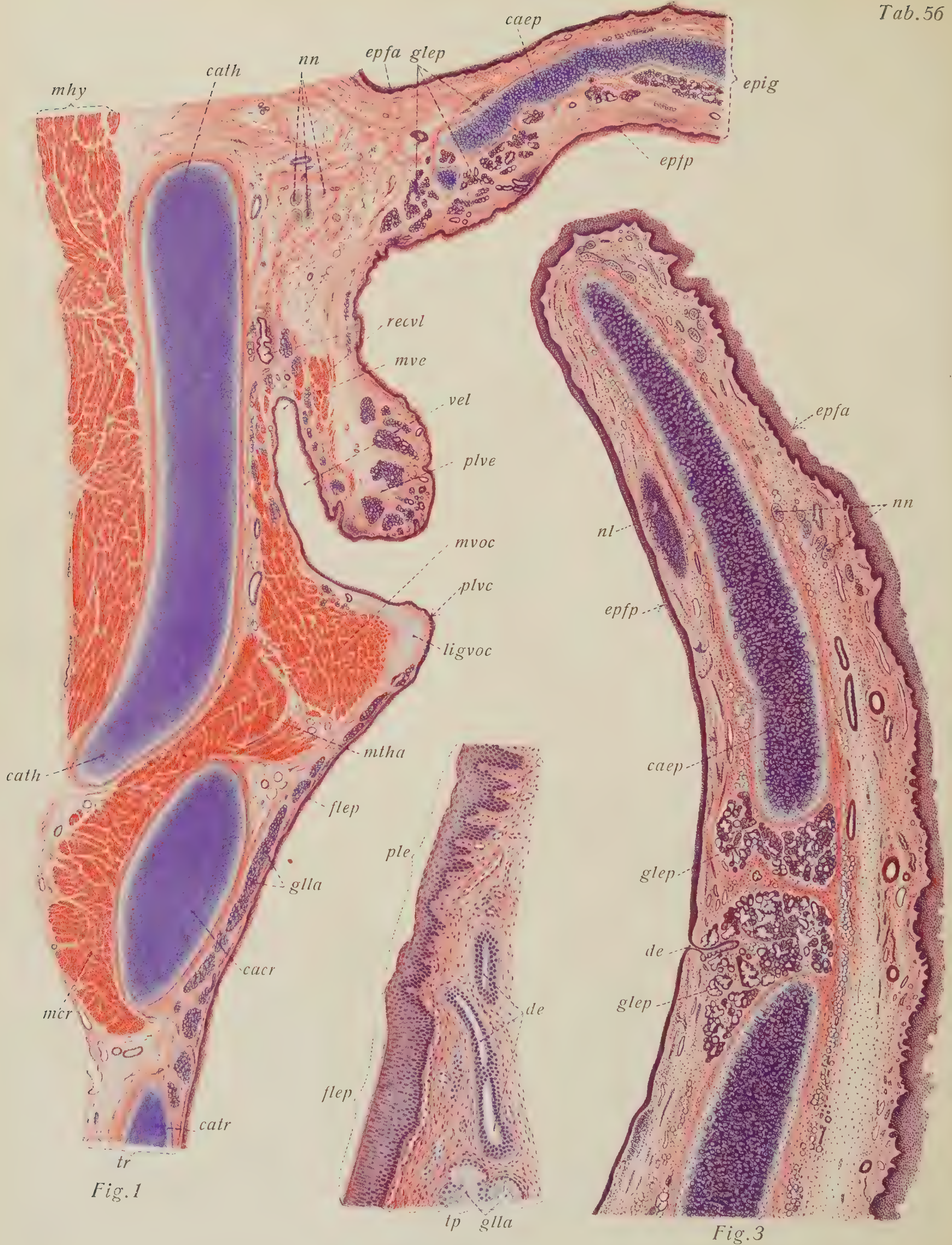


Fig. 3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flep
glla
cacr
mcr
catr
tr
ple
de
flep
tp
glla
epfa
nn
nl
epfp
caep
glep
de
glep

Fig.1

Fig.2

Fig.3

Plate 56. **Larynx I.**

Fig. 1. Frontal Section of a **Larynx** (Boy. aet. 8). × **4.3.** General view of the larynx. (Only a little more than one half of the section is represented.) Cricoid and thyreoid cartilages and that of the epiglottis are visible. The section cuts across the vocal cords, the ventricular folds, and the ventricle of the larynx between them; also the recessus ventriculi, the muscles of the vocal cords and the ligamentum vocale, other muscles of the larynx and the lower hyoid muscles. At the lower end of the preparation the upper part of the trachea is visible in section. **Technique:** Müller's fluid—formol. Celloidin. Haematoxylin-eosin.

Fig. 2. From a Frontal Section of a **Larynx.** × **100.** Part of the other half of the above section (see also *Fig. 1*, Pl. 57). There is seen a small area from the mucous membrane of the vocal cord where the ciliated epithelium passes into the stratified pavement epithelium. Beneath the latter are high papillae, in addition just here the laryngeal glands are wanting although they appear at once in the region of the ciliated epithelium (cf. *Fig. 1*, Pl. 57). **Technique** as for *Fig. 1.*

Fig. 3. From a Sagittal Section of an **Epiglottis** (Human, aet. 21. Execution). × **16½.** Both sides of the epiglottis are covered by mucous membrane and within it is seen its cartilage in which holes are often excavated by glands; the section cuts across such a hole. In spite of the low enlargement the difference is distinctly seen between the epithelium of the anterior surface turned toward the mouth cavity, and that of the posterior surface directed toward the aditus laryngis. The former has a thick stratified squamous epithelium with marked papillae, the latter it is true has also a squamous epithelium of several layers of cells, but its under surface is smooth and without papillae. At the aditus laryngis this latter epithelium passes gradually into a ciliated epithelium. In addition to the mucous glands a small lymph nodule is seen. **Technique** as for *Figs. 1 and 2.*

cacr = cricoid cartilage
caep = cartilage of epiglottis
cath = thyreoid cartilage
catr = tracheal cartilage
de = excretory duct
epfa = anterior surface of the epiglottis
epfp = posterior surface of epiglottis
epig = epiglottis
flep = ciliated epithelium
glep = glands of the epiglottis
glla = laryngeal glands
ligvoc = ligamentum vocale
mcr = cricothyreoid muscle
mhy = lower hyoid muscles
mtha = thyreo-arytaenoid muscle
mve = ventricular muscle
mvoc = musculus vocalis
nn = nerves
nl = lymph nodule
ple = squamous epithelium
plve = ventricular fold
plvc = vocal cord
recvl = recessus ventriculi laryngis
tr = trachea
tp = tunica propria
vel = ventriculus laryngis

Plate 57. **Larynx II, Trachea, Lung I.**

Fig. 1. Part of a Frontal Section through a **True Vocal Cord** (Larynx of Child). × **40.** The figure shows how the vocal cord consists of the musculus vocalis, the ligamentum vocale and the mucous membrane covering them. (For orientation see Pl. 56, *Fig. 1.*) Note that in the region of the vocal cord proper the mucous membrane is free from glands. These do appear in the projection which forms the vocal cord but only in its lower part where the ciliated epithelium begins. Over the vocal ligament the epithelium is stratified and near the free border of the cord it shows long papillae. **Technique:** Müller's fluid—formol. Celloidin. Haematoxylin-eosin.

Fig. 2. Transverse Section of the **Trachea** (Human, aet. 21. Execution). × **8.** General view. The entire membraneous part of the wall and about two-thirds of the cartilaginous part are represented, the former below and the latter above and to the left. The mucous membrane shows very slight folds which are a little deeper over the membraneous wall; its surface is covered by a stratified ciliated epithelium and within it are considerable masses of tracheal glands. These glands are most numerous where the cartilage gives most room for their development, consequently they are chiefly to be seen in the paries membranaceus, and where the ring of cartilage is cut near its edge as in the upper part of the figure. Where the ring of cartilage is thickest the glands are few, small, and much flattened. In the paries membranaceus the bodies of the glands for the most part lie outside the smooth muscle of which this part of the tracheal wall chiefly consists. **Technique:** as for *Fig. 1.*

Fig. 3. Part of the Preceding Section of Human **Trachea.** × **72.** A portion of the paries cartilagineus is represented. Above is the stratified ciliated epithelium, next the tunica propria with a few glands, and beneath lies the cartilage and its perichondrium. **Technique** and source as for *Fig. 2.*

Fig. 4. Part of a Section of **Lung** (**Human,** aet. 21. Execution). × **50.** Two bronchioles of the larger order and a number of alveoli are cut, as well as a few alveolar ducts. There is seen a small plate of cartilage which occupied the crotch where a bronchial branch of smallest size divided into the two bronchioles of the figure. The bronchiole on the left is cut exactly across; that at the right somewhat lengthwise. Note the deep longitudinal folds of the mucous membrane covered by only a single layer of ciliated epithelial cells. Glands and cartilage are no longer present but the smooth muscle continues. It has a circular arrangement and is not an unbroken layer but consists of separate, anastomosing rings of muscle as is shown by the bronchiole which is cut longitudinally. In the neighborhood of the two bronchioles is considerable anthracotic pigment (black). **Technique:** Müller's fluid—formol. Celloidin. Haematoxylin-eosin.

alv = alveoli
bg = blood vessels
da = alveolar ducts
ep = epithelium
ep_1 = stratified ciliated epithelium
ep_2 = stratified squamous epithelium
ep_3 = stratified squamous epithelium with papillae
gl = glands
gl_1 = glands of the paries cartilagineus
gl_2 = glands of the paries membranaceus

kn = cartilage
kn_1 = posterior end of cartilaginous ring
l = lumen
ligv = ligamentum vocale
m = smooth muscle
mv = musculus vocalis
plv = plica vocalis
tm = mucous coat
tp = tunica propria
* = transition from stratified squamous to stratified ciliated epithelium

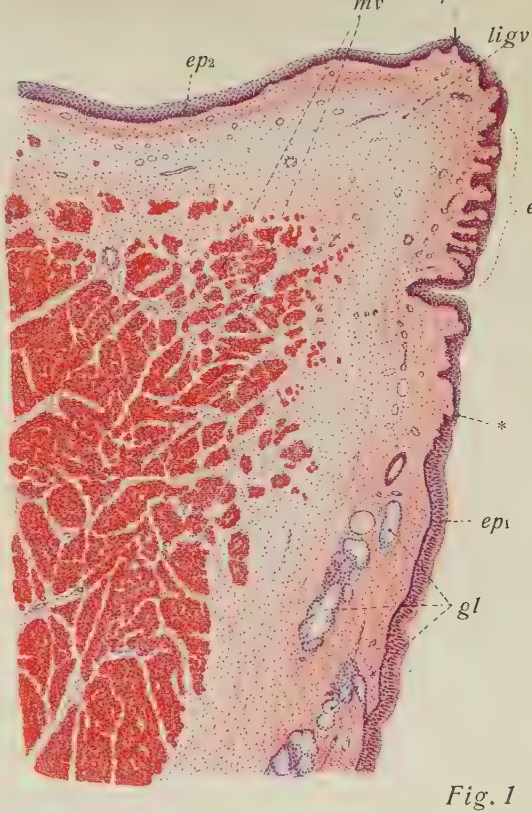
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Fig. 1

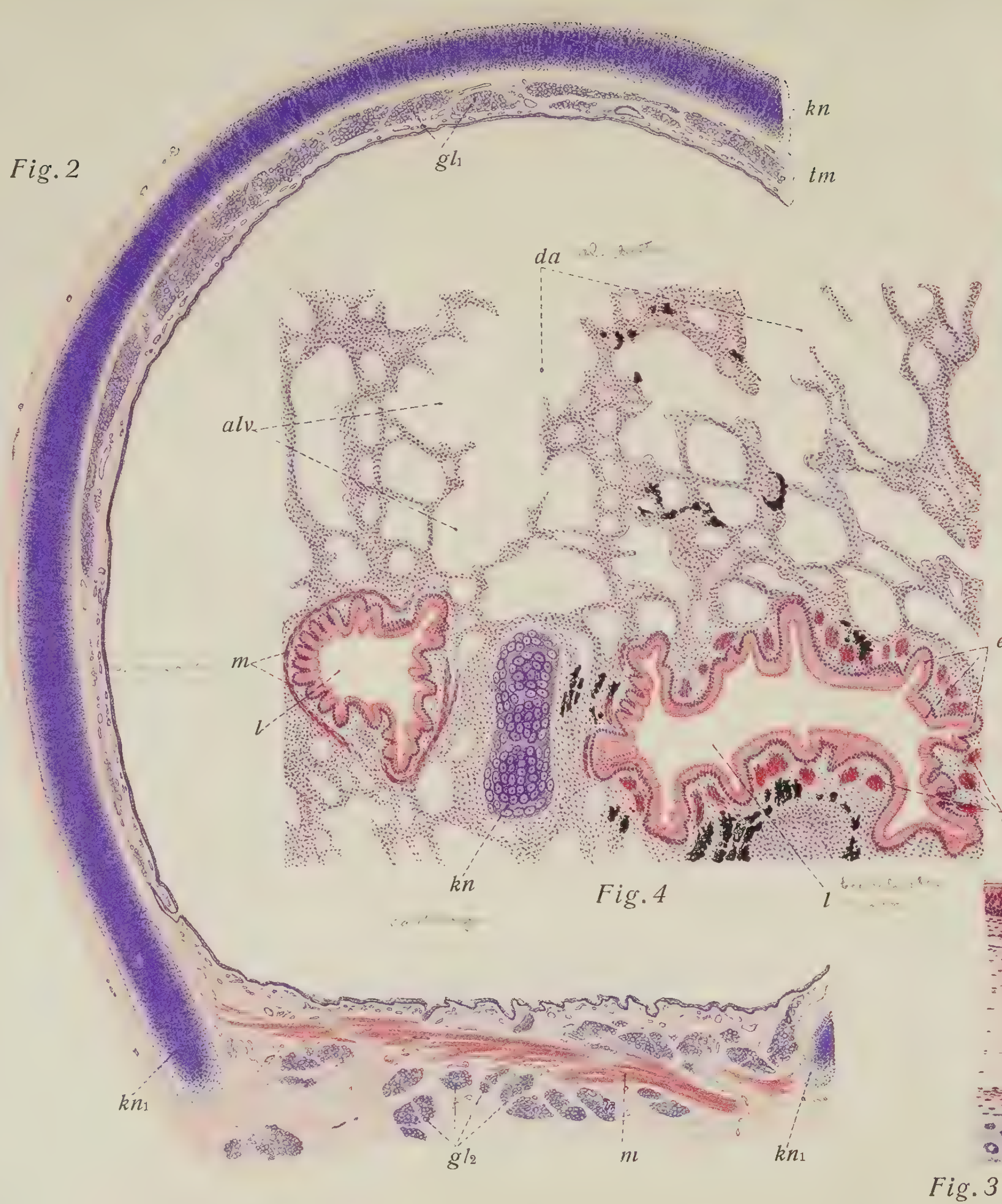
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Fig. 2

Fig. 4

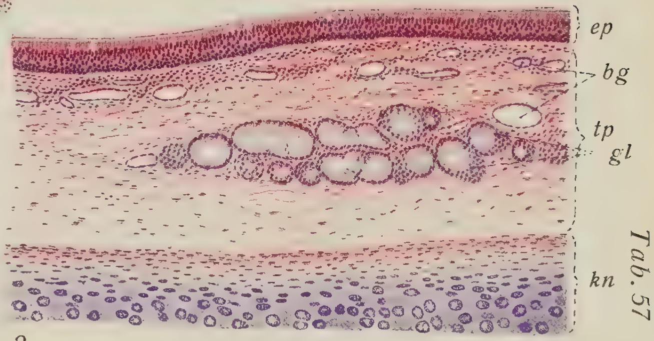
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Fig. 3

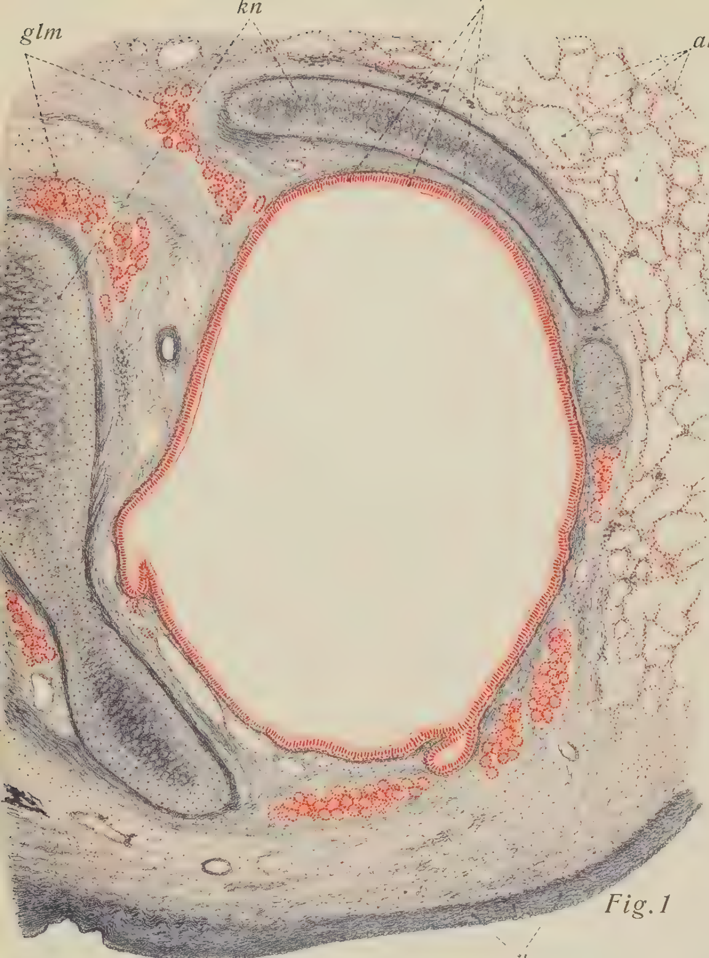
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Fig. 1

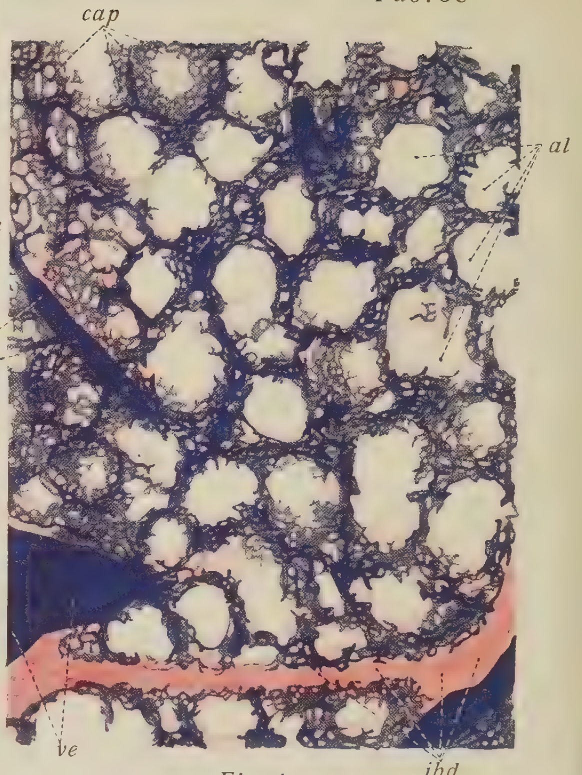
cap
al
arl
ve
ibd

Fig. 4

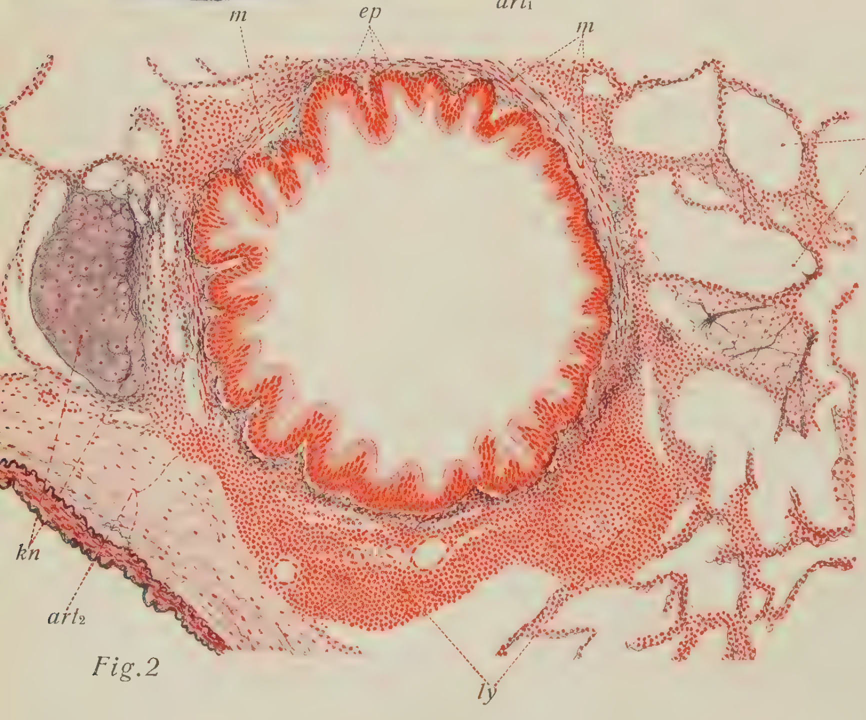
m
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Fig. 2

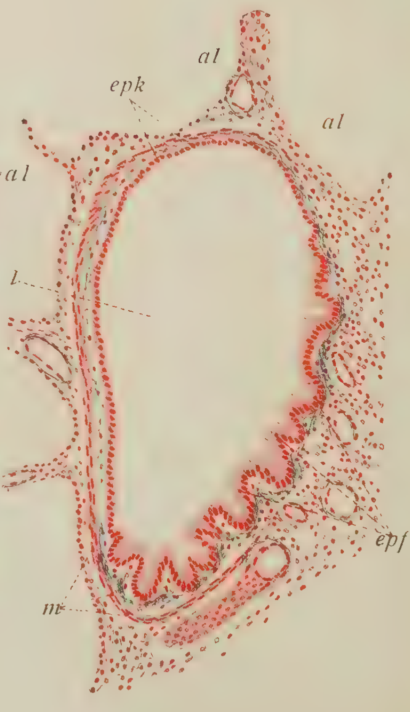
al
epk
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Fig. 3

Plate 58. **Lung II.**

Fig. 1. Transverse Section of a **Bronchus** of Medium Size (Human, aet. 22. Execution). × **35.** There is seen the bronchus with its large lumen and with strong plates of cartilage in its wall. Above and below are alveoli and at the bottom is a part of the wall of a large branch of the pulmonary artery. The elastic fibers are strongly stained dark violet; epithelial and all other nuclei are stained red. The mucous membrane within the bronchus shows but little folding; it has a stratified ciliated epithelium and numerous glands which are chiefly massed between the plates of cartilage. The abundance of elastic fibers is clearly apparent, the smooth muscle which lies beneath them is not so evident under the low enlargement. **Technique:** Zenker's fluid. Celloidin. Weigert's elastin stain. Paracarmine.

Fig. 2. Transverse Section of a Human **Bronchiole and Surrounding Pulmonary Tissue.** × **90.** The small plate of cartilage remaining in the wall marks this as one of the larger bronchioles, however glands are no longer present. A peribronchial mass of lymphatic tissue is seen. The ciliated epithelium is already very low but has not as yet become reduced to a single layer (cf. *Figs. 3 and 4*, Pl. 57). The mucous membrane is exceedingly rich in elastic fibers and forms high, ridgelike, longitudinal folds. Externally the smooth muscle is arranged circularly. Note the abundance of elastic fibers in the alveolar walls. **Technique** and source as for *Fig. 1.*

Fig. 3. Transverse Section of a **Bronchiole** from the Human Lung. × **100.** The figure shows a bronchiole of smallest caliber, in which the simple ciliated epithelium (lower right) passes into the flat-cubical, non-ciliated epithelium. Parts of a few adjacent alveoli are included. On the right the layer of smooth muscle seems lacking but is so only in appearance, for the gap is left between the bundles of muscle which anastomose and encircle the bronchiole. **Technique** and source as for *Fig. 2.*

Fig. 4. Part of a Section from a Human **Lung Injected** with a Blue Colored Mass. × **100.** By filling them artificially the blood vessels supplying the lung are clearly seen. On the left is a small artery the branches of which finally pass into wide capillaries which form networks of narrow meshes in the walls of the alveoli. Beneath the artery is a larger branch of a vein. The pulmonary tissue proper is stained red. **Technique:** Injection. Staining in toto with borax carmine.

al = alveoli
art = artery
art_1 = part of the wall of a larger artery
art_2 = part of the wall of a smaller artery
cap = capillaries
ep = epithelium
epf = epithelium covering the longitudinal folds
epk = nuclei of epithelium
glm = mucous glands
ibd = interstitial connective tissue
kn = cartilage
l = lumen
ly = lymphatic tissue
m = smooth muscle
pch = perichondrium
ve = vein

Plate 59. Lung III, Thyreoid Gland I, Kidney I.

Fig. 1. Part of a Section from a **Human Lung Injected with Silver-gelatine. × 900.** There is seen a small bronchiole cut longitudinally for some distance; the blackened cell boundaries show its epithelium gradually changing into the so-called respiratory epithelium. Nearby are alveoli with the characteristic lining of respiratory epithelium and much carbon pigment. **Technique:** Injection with silver-gelatine. Section exposed to light in acidulated water.

Fig. 2. Wall of an **Alveolus from a Lung Treated as Above. Respiratory Epithelium. × 300.** Cell boundaries blackened by the silver; distinct alveolar pores. **Technique** as for *Fig. 1.*

Fig. 3. Surface View of the **Pleural Epithelium** Treated with Silver. × **500.** Practically only the cell boundaries appear as unusually broad lines. Nuclei are not visible **Technique** as for *Fig. 1.*

Fig. 4. Part of a Section from the **Thyreoid Gland** (**Human,** aet. 23. Execution). × **80.** The follicles are seen to differ greatly in size and in the extent to which they are filled with colloid. In the interstitial connective tissue lies a lymph vessel containing the so-called pseudo-colloid. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 5. Part of a Very Thin Section of the **Thyreoid Gland** (**Human,** Execution). × **600.** The follicular epithelium is seen very clearly to lie directly upon the interstitial connective tissue without the interposition of a basal membrane. Granules of colloid are distinctly seen within the cells of the gland. **Technique:** Sublimate solution. Paraffine. Iron haematoxylin.

Fig. 6. **Interstitial Connective Tissue** (Reticulum Fibers) of the Cortex of the Human **Kidney.** × **320.** The extremely scanty tissue between the tubules of the renal cortex consists exclusively of so-called precollagenous reticulum fibers, which also form the basal membranes of the tubules themselves. **Technique:** Formol. The Bielschowsky-Studnicka silver process. Staining of nuclei with haematoxylin.

al = alveoli
bd = connective tissue
bro = bronchiole
epz = epithelial cells
ery = erythrocytes
fep = follicular epithelium
gf = reticulum fibers
grf = large follicle of thyreoid gland
grz = large cells of the respiratory epithelium
infep = interfollicular epithelium
k = nuclei
kif = small follicles of thyreoid gland
klz = small cells of the respiratory epithelium
koll = colloid
kollgr = granules of colloid
lg = lymph vessel
pa = alveolar pores
pi = carbon pigment
= pseudo-colloid in a lymph vessel
* = mucous (?) cysts in the colloid
** = space formed by shrinkage of the colloid

Tab. 59

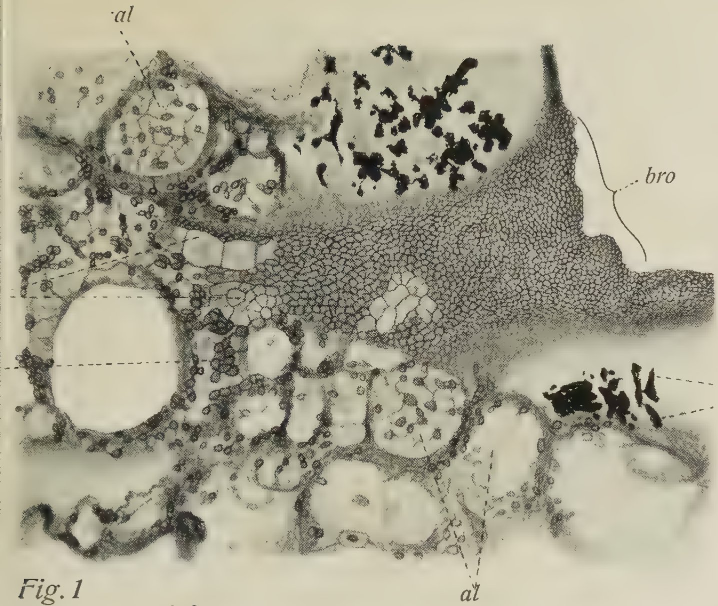


Fig. 1

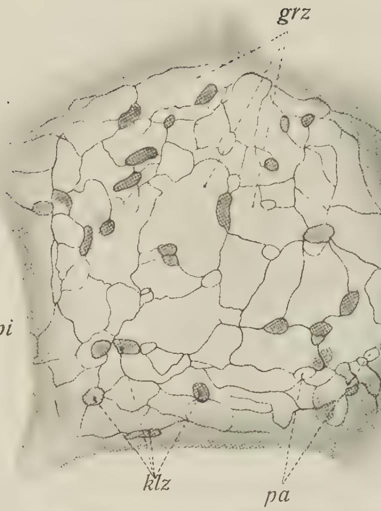
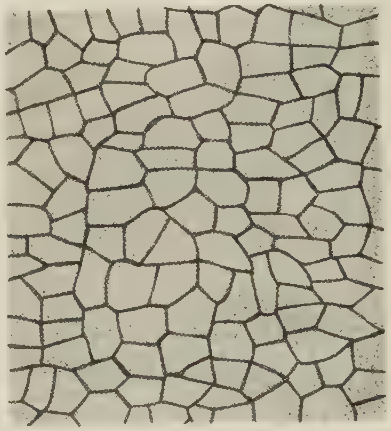


Fig. 2

Fig. 3



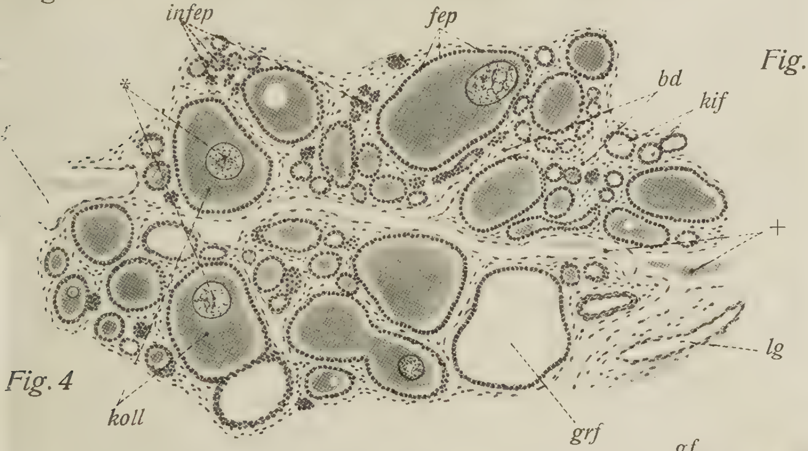

infep
fep
*
bd
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Fig. 4

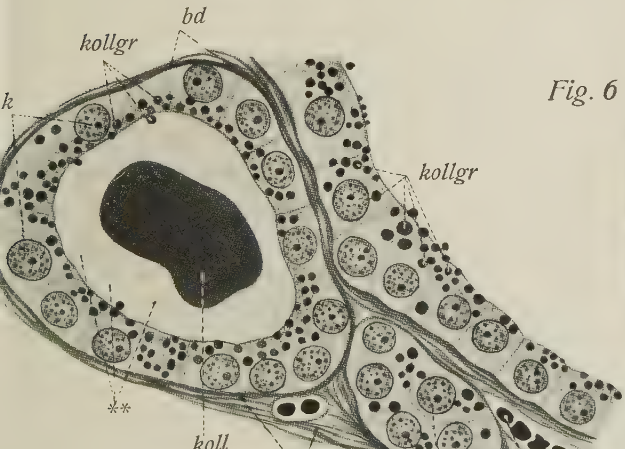
bd
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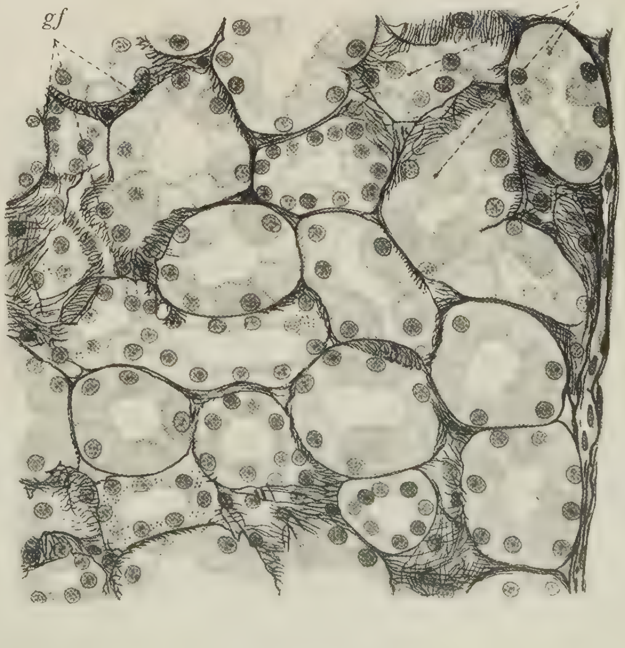
Fig. 5

Fig. 6



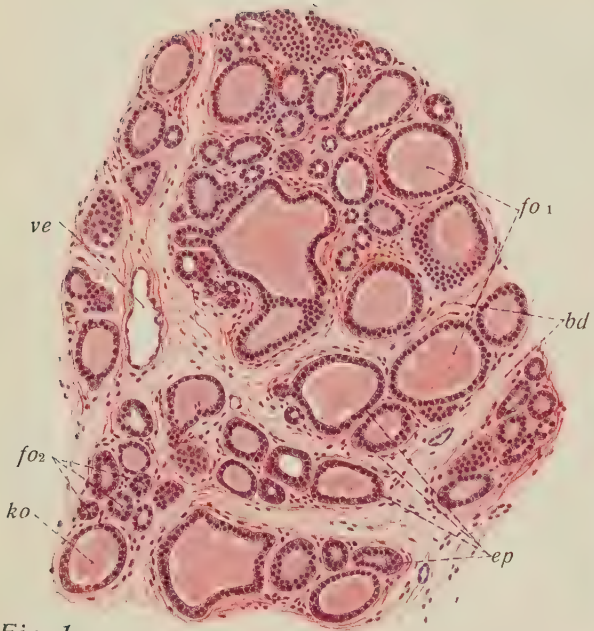

ve
fo1
bd
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Fig. 1

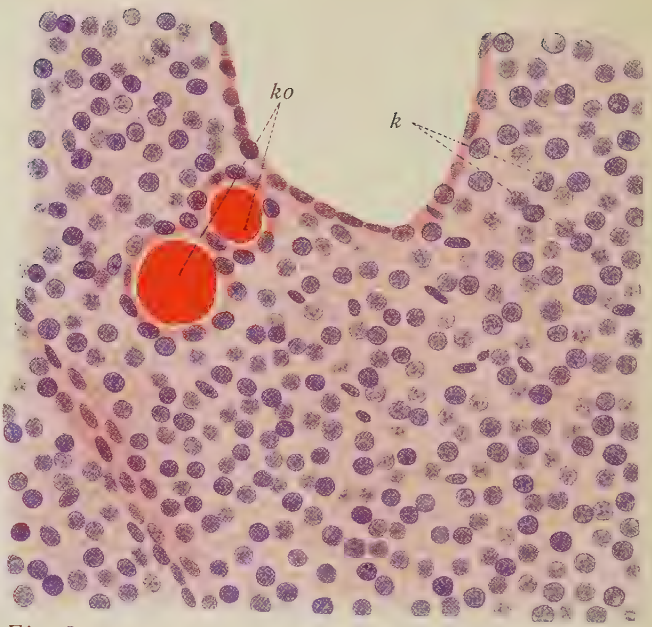

Fig. 2

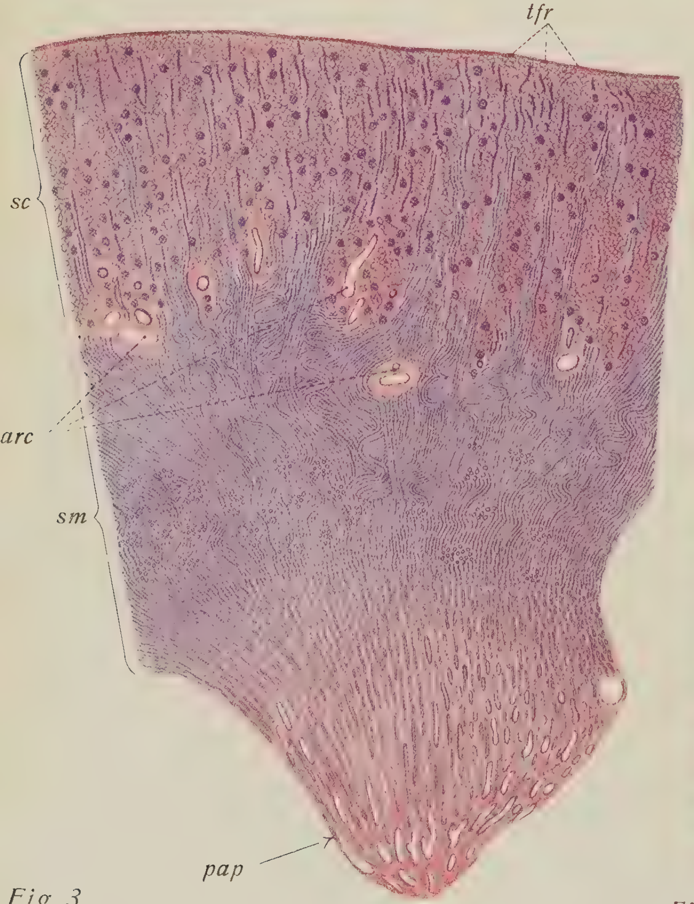
tfr
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Fig. 3

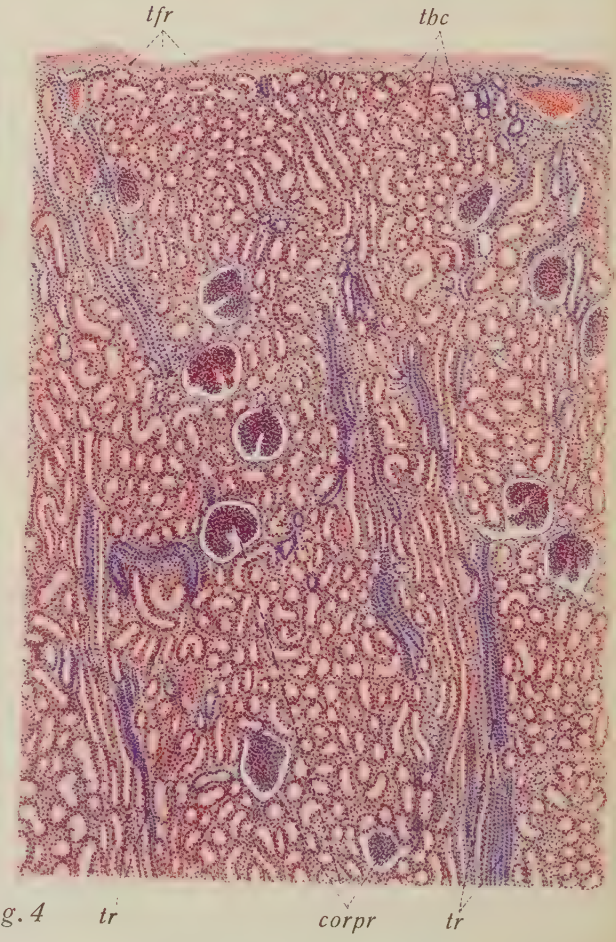
tfr
tbc
tr
corpr
tr

Fig. 4

Plate 60. **Thyreoid Gland I, Parathyreoid Gland, Kidney II.**

Fig. 1. Part of a Section from a **Thyreoid Gland** (Human, aet. 21. Execution). × **120.** There are seen a number of closed, glandular vesicles (so-called follicles) which differ greatly in diameter; many have but a very small lumen and are empty, others are wider and are filled with colloid. The solid masses of cells in part represent the so-called interfollicular epithelium and in part are tangential sections through follicles with small lumina. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 2. Part of a Section of the Human **Parathyreoid Gland.** × **500.** The epithelial cells of this endocrine gland are arranged in irregular masses or cords; only occasionally does colloid appear, and for the most part no trace of a lumen is to be seen. Note how greatly the structure differs from that of the thyreoid gland. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Section Perpendicular to the Surface of a **Kidney** (Human, aet. 28. Execution). × **7.** General view. There is seen the entire thickness of cortex and medulla, and their distribution. The section extends from capsule to papilla. The large vessels, the so-called arcuate arteries and veins, are clearly seen along the boundary between cortex and medulla (cf. the diagram *Fig. 33*, Vol. I). Within the cortex the pars convoluta (labyrinth) and the pars radiata (medullary ray) alternate; in the pars convoluta the renal corpuscles are visible as dark spots.

Fig. 4. Part of a Section from the Human **Renal Cortex.** × **40.** Detail of *Fig. 3.* Above is seen the tunica fibrosa (capsule) and immediately beneath it a stellate vein filled with blood. Otherwise the figure shows only the cortex of the organ consisting of the pars convoluta with the renal corpuscles etc. and of the pars radiata, the slender extensions of the medulla formed of the tubuli recti. The composition of the renal corpuscle from glomerulus and Bowman's capsule can already be clearly recognized; and at the right the relation between capsule and convoluted tubule can be seen even under this magnification. **Technique** as for *Fig. 1.*

bd = connective tissue
corpr = renal corpuscles
ep = follicular epithelium
fo_1 = large follicles filled with colloid
fo_2 = small follicles and interfollicular epithelium
k = nuclei of epithelial cells of the parathyreoid gland

ko = colloid
pap = renal papilla
sc = cortex
sm = medulla
tbc = convoluted parts of renal tubules
tfr = renal capsule
tr = straight parts of renal tubules
varc = arcuate vessels
ve = vein

Plate 61. **Kidney III.**

Fig. 1. A Small Part of a Section from the Most Superficial Zone of the **Renal Cortex (Human,** aet. 21. Execution). × **320.** The upper part of the figure shows the capsule beneath which lie, close together, sections of the proximal and distal convoluted parts of the renal tubule. Apart from their differences in caliber, which are not very great, the two parts of the tubule are distinguished by a very different degree of oxyphily in the protoplasm; the proximal parts are red, the distal parts rather violet, the bases of the cells of the proximal parts show a striation but the brush border is not to be seen; coagula of secretion lie in the lumen. Note how slight is the amount of connective tissue between the tubules (cf. *Fig. 6,* Pl. 59). **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 2. A Small Section of **Renal Cortex** (Human, aet. 22. Execution). × **720.** Sections of proximal and distal parts of renal tubules are seen surrounding a renal corpuscle. The glomerulus contains some erythrocytes, stained red, their position indicates the capillaries which otherwise are not to be distinguished from the connective tissue. The (Bowman's) capsule of the renal corpuscle is shown as it is continued into the first turn of the proximal convoluted part of the tubule. **Technique** as for *Fig. 1.*

Fig. 3. Transverse Section of a **Proximal Convoluted Tubule** (Human, aet. 21. Execution). × **900.** The membrana propria of the tubule is seen, also the basal striation of the epithelium, the brush border, and the nuclei. Cell boundaries are not recognizable. Droplets of secretion (artefacts ?) lie in the lumen. **Technique** as for *Fig. 1.*

Fig. 4. Two **Renal Tubules** from a **Medullary Ray** (Human, aet. 21. Execution). × **720.** On the left is a distal (ascending) limb of a loop of Henle, on the right a straight piece from the convoluted part of a tubule. The epithelium of the latter is high, the cell boundaries scarcely indicated, the cytoplasm granular, basal striation and brush border are distinct. On the left, in the piece from the loop, the cytoplasm is less granular; there is no brush border but the basal striation is indicated and the cell boundaries are evident. **Technique** as for *Fig. 1.*

Fig. 5. A Small Part of a Section of the **Medulla** from a **Human Kidney.** × **320.** In the middle is a collecting tubule, right and left are thick-walled limbs of loops of Henle in each case cut near the bend of the loop, which is itself shown on the right. Note how much more strongly developed the interstitial connective tissue is here in the medulla than it is in the cortex. **Technique** and source as for *Fig. 1.*

Fig. 6. **Descending** (Thin-Walled) **Limbs of Loops of Henle.** × **320.** From a section similar to that of *Fig. 5.* In the middle is a renal tubule cut tangentially, right and left of it are the thin-walled descending limbs of long loops of Henle; on the left the bend of the loop is cut. Note the flat cells of the wall with their projecting nuclei. **Technique** as for *Fig. 1.*

Fig. 7. Transverse Section of the Renal **Medulla** (Human, aet. 28. Execution). × **150.** There are seen cross sections of collecting tubules lined with high epithelium and sections of descending limbs of loops of Henle marked by flat epithelium. Sections of blood vessels, small veins and capillaries, lie in the relatively abundant interstitial connective tissue of the medulla. **Technique** as for *Fig. 1.*

bd = connective tissue
bür = brush border
cap = capillaries
capgl = glomerular capsule
dist = ascending limb of loop of Henle
gl = glomerulus
k = nuclei
mp = membrana propria
prox = descending limb of loop of Henle
sch = distal convoluted parts of renal tubules
schl = bend of loop of Henle
st = striation
tc = proximal convoluted parts of renal tubules
tf = renal capsule (tunica fibrosa)
tr = collecting tubule
+ = opening from renal corpuscle into renal tubule

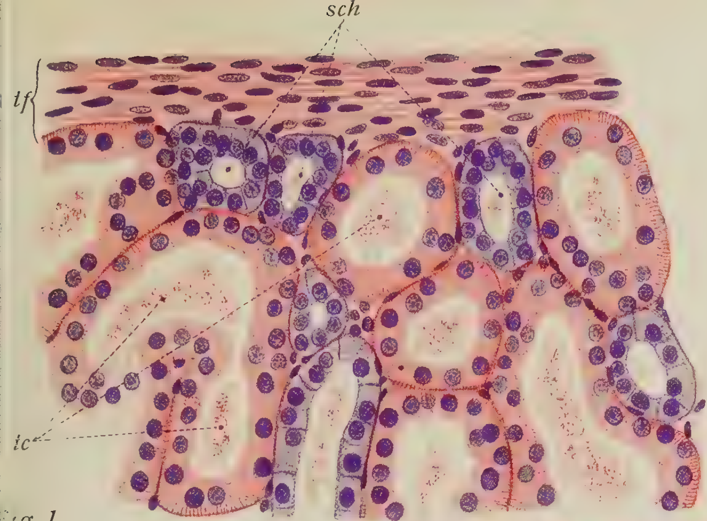

Fig. 1

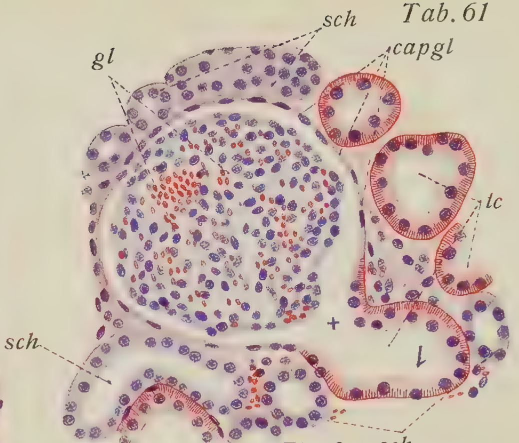
sch
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Fig. 2

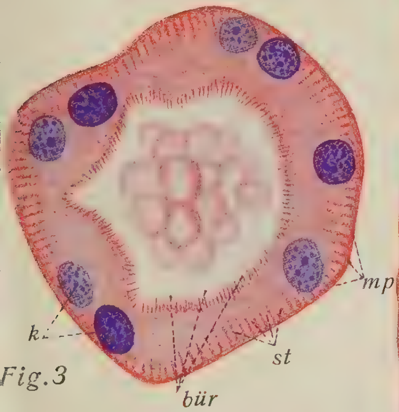

Fig. 3

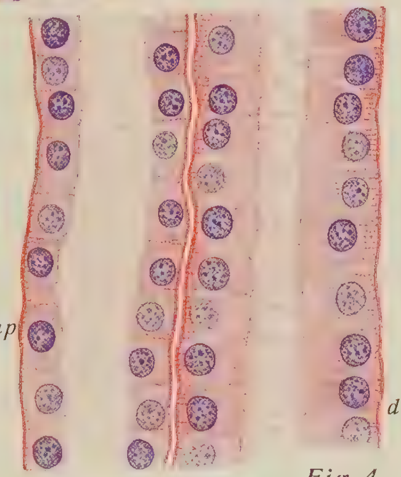

Fig. 4

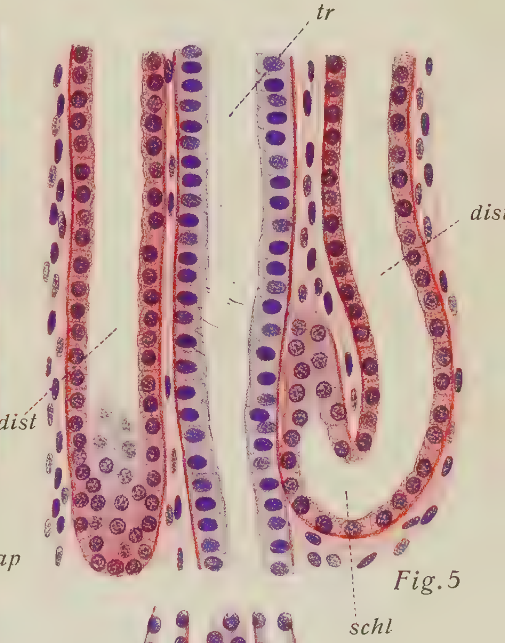
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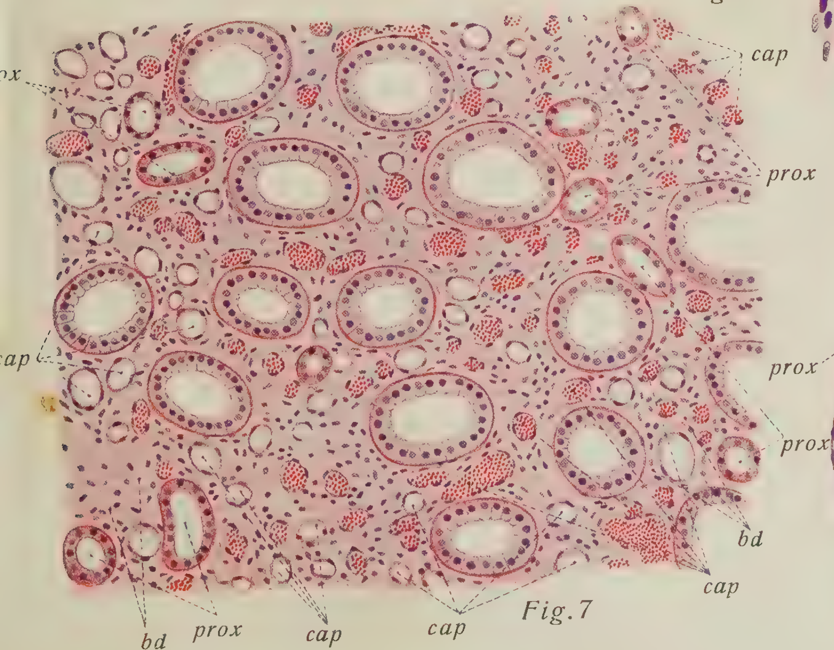
Fig. 5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prox
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cap

Fig. 7

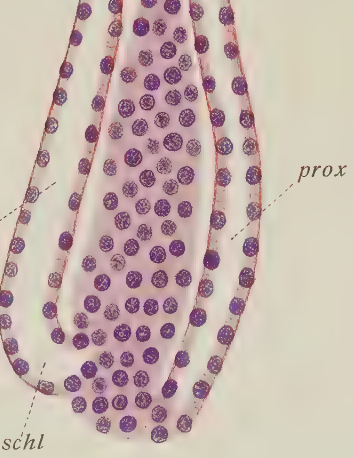
prox
prox
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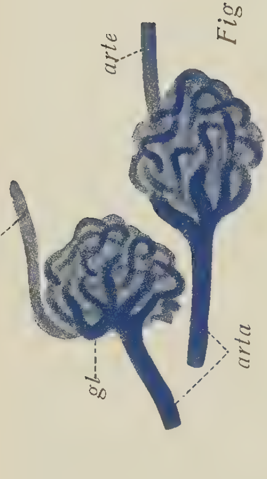
Fig. 6

Tab. 62



arte
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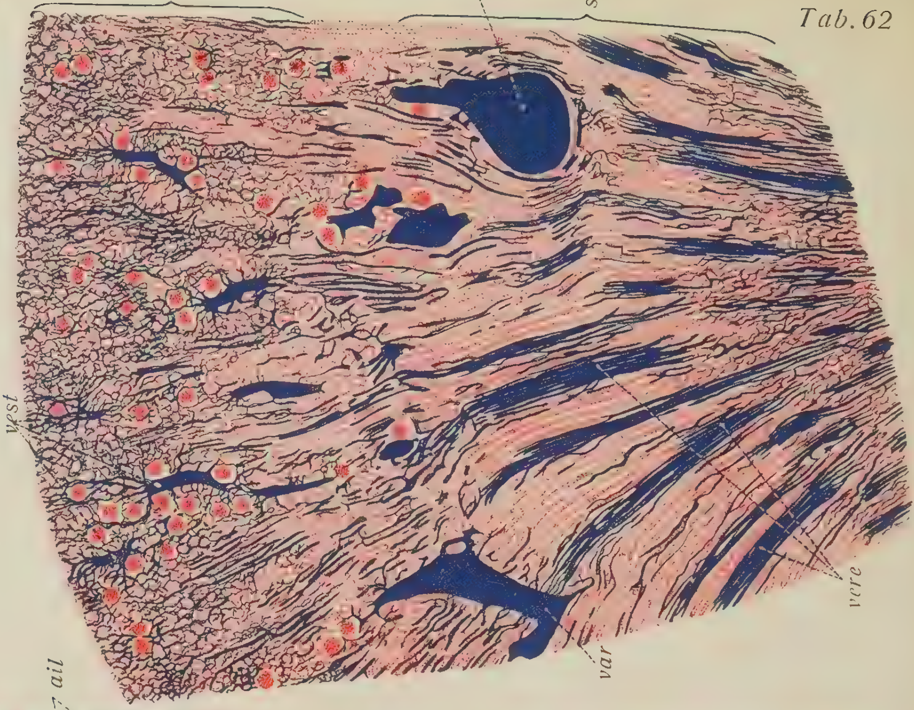
Fig. 2



vest
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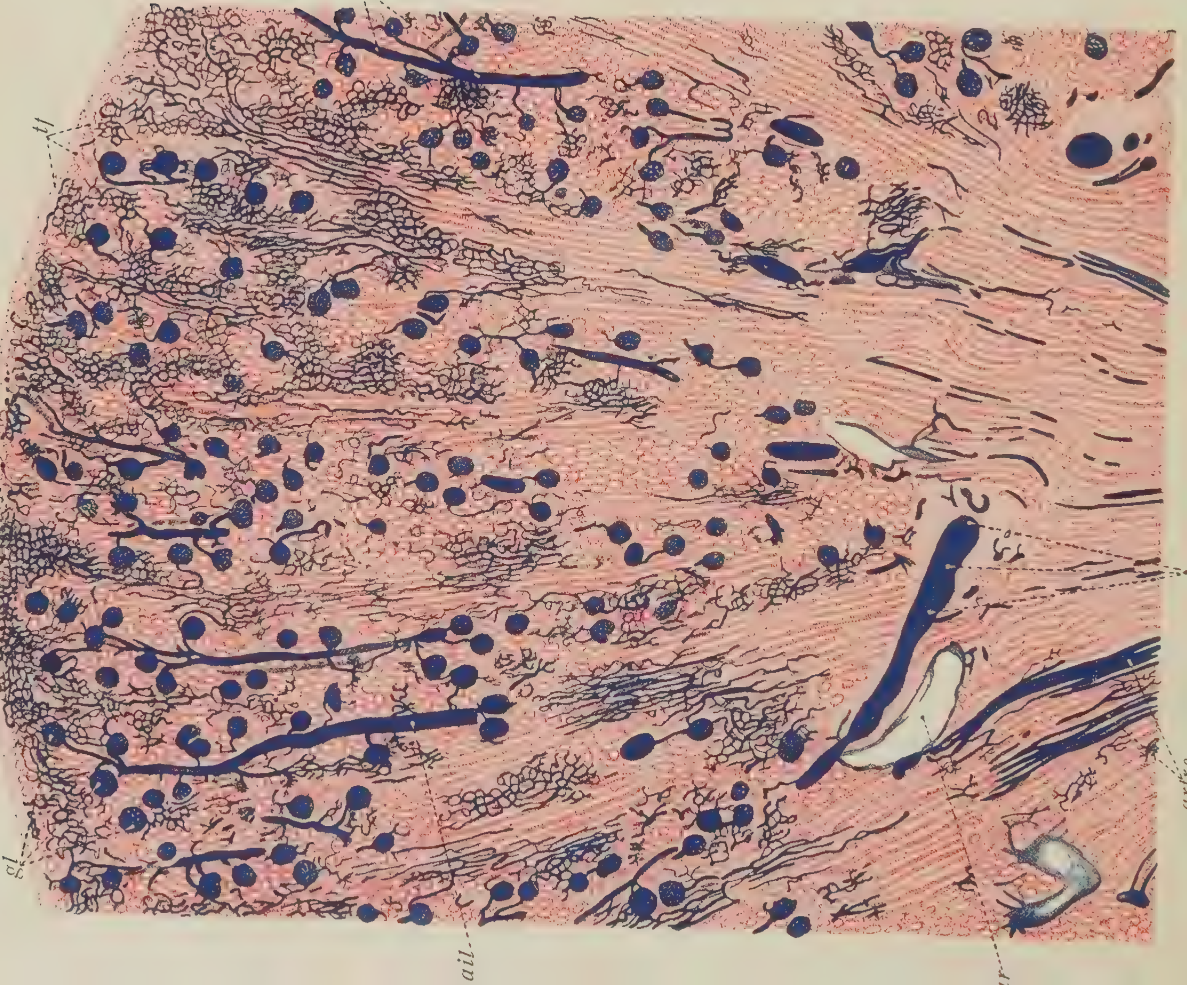
Fig. 3



tf
ail
vc
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ail
aar
artre

Fig. 1

Plate 62. **Kidney IV.**

Fig. 1. Part of a Section from a Human **Kidney Injected through the Artery** with Berlin Blue. × **20.** General view of the distribution of the vessels. Below is an area of medulla with a few groups of the arteriolae rectae; and at the boundary of cortex and medulla the arcuate arteries are seen. Only the arteries and capillaries are filled with the injection material which did not reach the veins; thus all that appears blue in the figure represents either arteries or capillaries. For instance the capillaries of the glomeruli are filled and appear blue. The principal part of the figure is cortex in which areas of labyrinth alternate with medullary rays; both are shown clearly by their red-stained nuclei. The capillaries of the cortex are evident and also the interlobular arteries with numerous glomeruli connected to them. **Technique:** Injection with Berlin Blue in gelatine. Müller's fluid. Staining in toto with borax carmine. Celloidin.

Fig. 2. Two Isolated **Glomeruli** from an Injected Human Kidney. × **120.** In addition to the coiled vessels of the glomerulus itself there are seen the larger, afferent and the smaller, efferent arterioles. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Section from a **Kidney Injected through the Vein** with Berlin Blue (Guinea Pig). × **17.** The figure shows the cortex and a considerable part of the medulla. Beside the great arcuate veins there may be recognized the interlobular veins with their radicles, the stellate veins, lying close to the surface. The venulae rectae of the medulla are also shown. The glomeruli are not injected but appear as circular masses of red nuclei surrounded by capillaries injected with blue. The injection has passed from the veins into the capillaries but no farther, consequently the arteries and the glomeruli are not filled. As a rule the points of entrance of the afferent arteriole, and of exit of the efferent arteriole lie near together in the so-called neck of the glomerulus. In this figure the efferent arterioles are not visible throughout their length. **Technique** as for *Fig. 1.*

aar = arcuate artery
ail = interlobular artery
arta = afferent arteriole
arte = efferent arteriole
artre = arteriolae rectae
gl = glomeruli
sc = cortex

sm = medulla
tf = renal capsule
va (var) = arcuate vein
vc = capillaries
vere = venulae rectae
vest = stellate veins, also interlobular veins

Plate 63. **Urinary Tract I.**

Fig. 1. A Section through the **Wall of a Renal Calyx** and the Adjacent Part of a **Renal Papilla** (Human, aet. 21. Execution). × **80.** On the right a part of the papilla is visible with its covering of epithelium. The latter begins as a simple cubical epithelium which gradually changes into one possessing a few layers of cells and finally becomes a typical transitional epithelium. On the left is seen a part of the wall of a renal calyx with a well–marked transitional epithelium on its surface. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. A Transverse Section through a Human **Ureter.** × **30.** General view. The mucous coat bears a thick transitional epithelium and has fallen into folds because the lumen is empty. The lumen is noticeably large in proportion to the thickness of the wall. The tunica propria is rich in cells and passes gradually into the looser submucous connective tissue without showing a sharp boundary between mucous and submucous coats such as obtains in the digestive tract. Glands are lacking. The muscular coat is not compact, but is weak and its layers are not sharply defined. Usually both outer and inner longitudinal bundles may be distinguished, between which lies a middle circular layer of muscle; the individual bundles are always separated by considerable connective tissue. Adventitious connective tissue surrounds the whole. **Technique** and source as for *Fig. 1.*

Fig. 3. Part of a Transverse Section of a **Human Ureter.** × **50.** The structure of the wall of the ureter as outlined above is here more clearly displayed. Note among other things how close the capillaries of the tunica propria lie to the basal surface of the transitional epithelium, even causing indentations. The arrangements of the muscle in separate bundles is especially clear. **Technique** and source as for *Fig. 1.*

Fig. 4. A Section through the Wall of the Human **Urinary Bladder.** × **18.** General view. The picture recalls the structure of the wall of the ureter but the muscular coat is disproportionately thick and is more compact. The mucous membrane, like that of the ureter, is devoid of glands and is characteristic of the bladder. The layers of muscle are more regular than in the ureter. The preparation was taken from a rather empty bladder. As the bladder fills and the organ becomes distended the layers of the wall, particularly the muscular coat, diminish correspondingly in thickness. **Technique** and source as for *Fig. 1.*

cal = wall of renal calyx
bd = connective tissue
c = capillaries
dup = papillary ducts
ep = epithelium
ep_1 = cubical epithelium of the tip of the papilla
ep_2 = transitional epithelium of the calyx
fez = fat cells
ilm = inner longitudinal muscle
mu = muscular coat
mu_1 = inner layer, longitudinal muscle
mu_2 = middle layer, circular muscle
mu_3 = outer layer, longitudinal muscle
mub = bundles of muscle fibres
pap = renal papilla
rm = layer of circular muscle
su = submucous tissue[1]
tp = tunica propria
* = beginning of stratified epithelium

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[1] In Fig. 2 the leader passes through the submucous tissue and tunica propria into the epithelium.

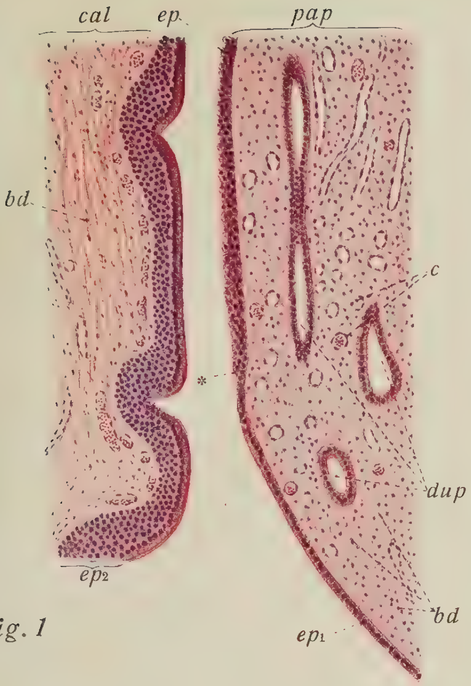
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Fig. 1

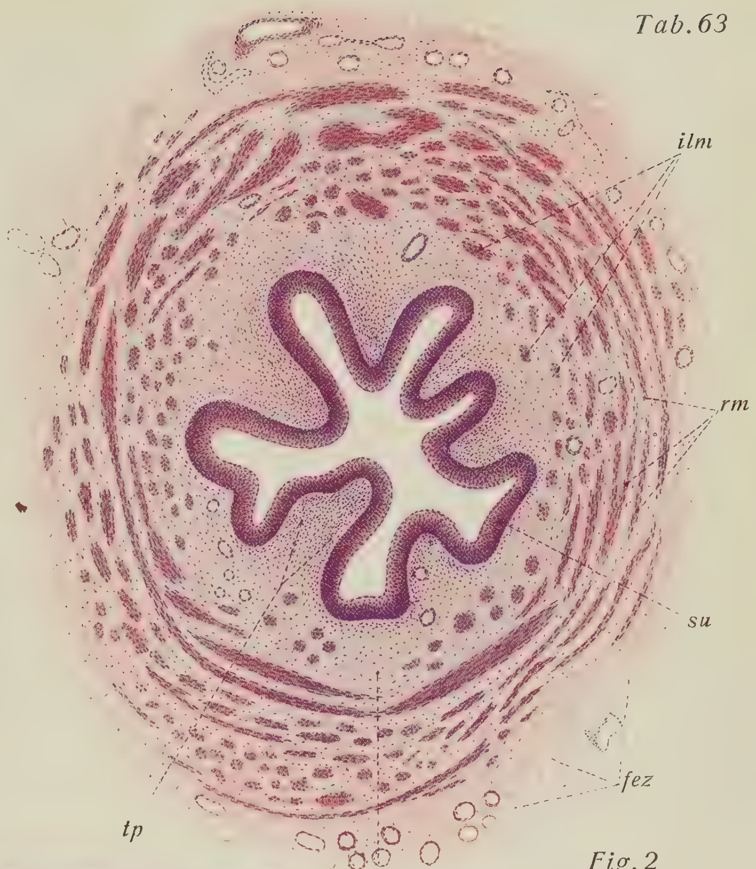
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Fig. 2

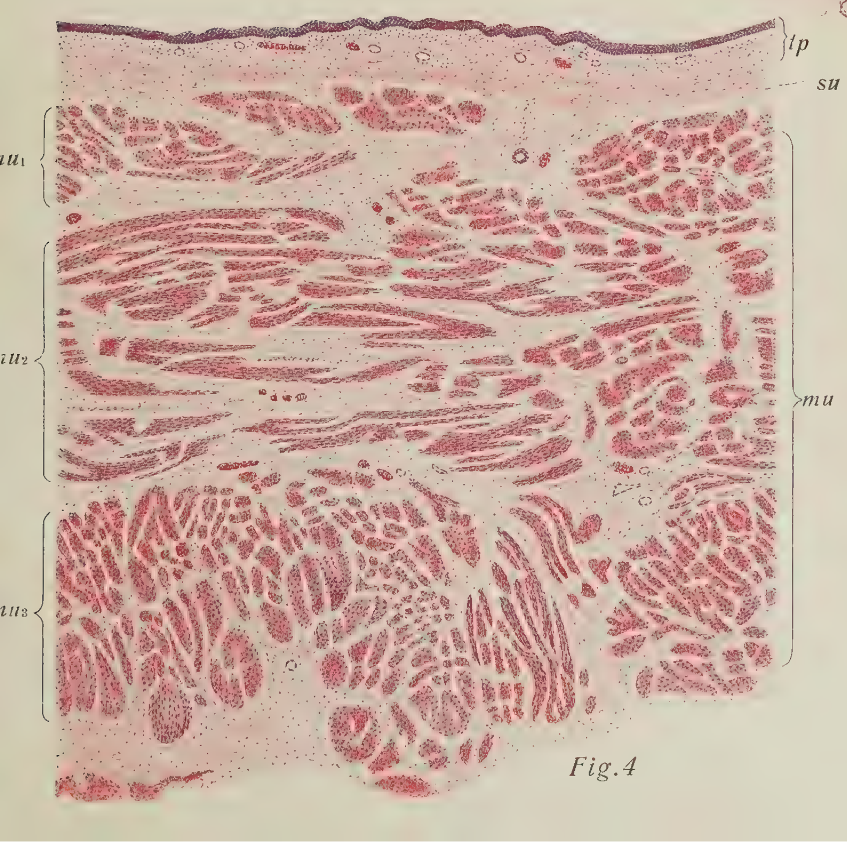
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Fig. 4

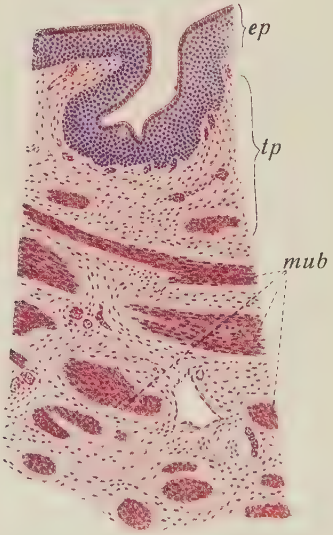

Fig. 3

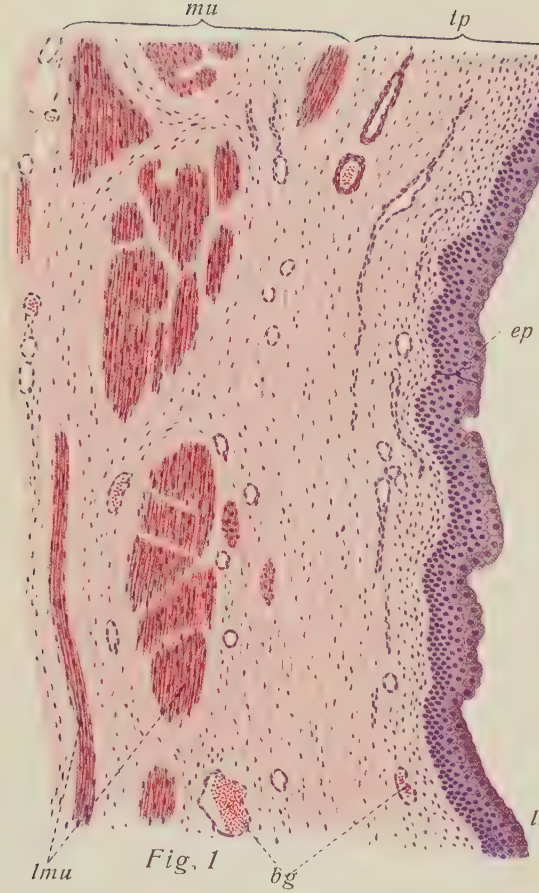
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Fig. 1

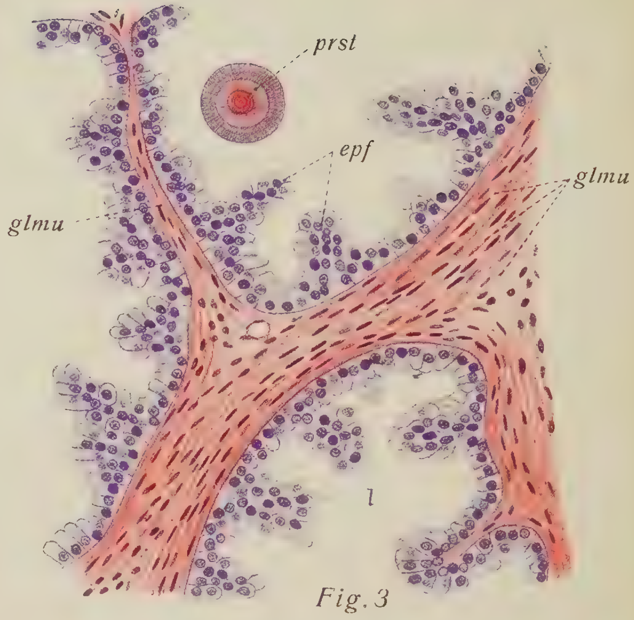
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Fig. 3

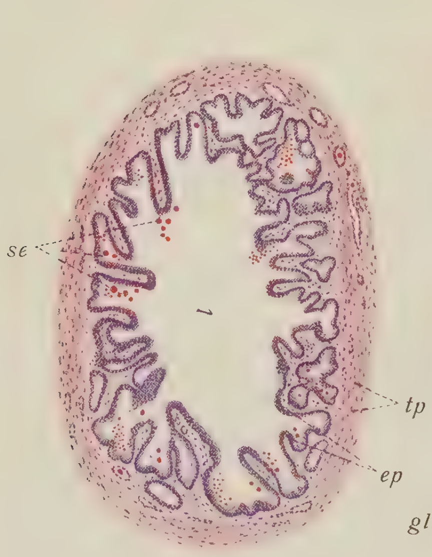


Fig. 4

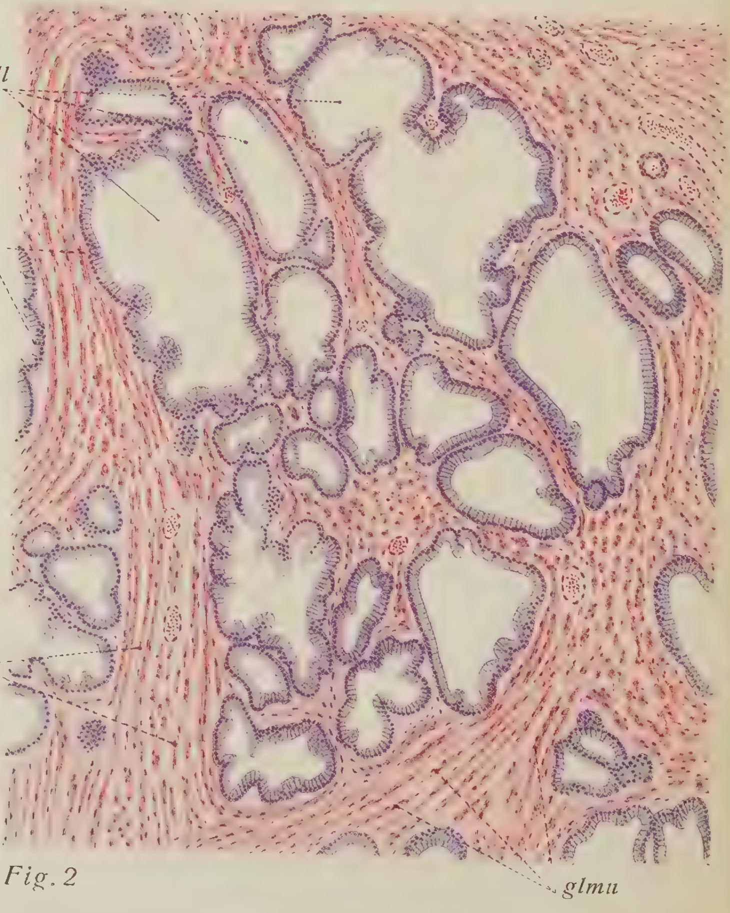

ll
ep
glmu
glmu

Fig. 2

Plate 64. **Urinary Bladder II, Prostate.**

Fig. 1. Part of a Section through the Wall of the **Urinary Bladder** (**Human,** aet. 22. Execution). × **90.** It is chiefly the mucous coat that is represented, only the superficial layers of muscle being included. Note the transitional epithelium which, because the bladder is scarcely distended, appears here to contain several rows of cells (cf. *Fig. 5,* Pl. 3). The mucous membrane contains no glands and passes without sharp demarcation into the submucous tissue, beneath which in turn lies smooth muscle. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of a Section from a **Prostate Gland** (**Human,** aet. 22. Execution). × **55.** This peculiar organ is seen to be formed partly of muscle and partly of glands. The section is from the lateral lobe of the organ where the glandular material greatly predominates over the muscular elements. The lumina of the glands are wide, and irregular in shape. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Section from a **Prostate Gland** (**Human,** aet. 22. Execution). × **200.** Parts of the walls of three adjacent alveoli are seen to be separated by only a small amount of smooth muscle. Note the delicate folds which when cut tangentially seem to consist entirely of epithelium. The epithelium is usually a single layer of somewhat cubical cells. In one lumen is a small prostatic concretion clearly formed of concentric layers. **Technique** as for *Fig. 1.*

Fig. 4. A Section through a **Ductus Ejaculatorius** (Human, aet. 21. Execution). × **25.** The duct is of unusually small caliber. Since it lies within the muscle of the prostate it dispenses with a muscular wall of its own, so that it is really bounded merely by a mucous membrane that shows deep folds and pockets. The epithelium is a single layer of cells ranging from cubical to columnar in form. Particles of secretion lie in the lumen. **Technique** as for *Fig. 1.*

bg = blood vessels
ep = epithelium
epf = tangential sections of epithelium
glmu = smooth muscle
l(ll) = lumen (lumina)
lmu = bundles of longitudinal muscle
mu = part of muscular coat
prst = prostatic concretion
se = secretion
tp = tunica propria

Plate 65. **Testis I.**

Fig. 1. A Transverse Section through the **Entire Testis** of a Child (Testis, Epidymis and Ductus Deferens). × **15.** The immature testis with its tunica albuginea, its lobules and septa, and the mediastinum testis occupies the middle of the figure; on the right the body of the epididymis is cut through and on the left the ductus deferens. Note how little the seminiferous tubules are developed as yet. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of a Section through the **Testis of an Adult** (Human, aet. 22. Execution). × **40.** Above there is seen the tunica albuginea, and a septum proceeding from it, also parts of the adjacent lobules. Within the lobules the tubuli contorti are loosely held together. They have wide lumina and an epithelial wall of several layers of cells in which evidences of spermatogenesis may be recognized notwithstanding the low enlargement. Between the tubules lies an interstitial tissue which contains numerous groups of large cells with abundant cytoplasm. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 3. A Section through the **Mediastinum and Rete Testis** (Human, aet. 26. Execution). The canals of the rete testis lie in the connective tissue of the mediastinum and show thin walls and narrow lumina; while on both sides are seminiferous tubules. The tubules of the rete testis are much the narrower and their wall consists of but a single layer of flat epithelium. **Technique** as for *Fig. 2.*

Figs. 4 and 5. Portions of Sections through the Walls of the **Tubuli Contorti** of the Testis of an Adult (Human, Operation). × **420.** (Cf. Pl. 66, *Figs. 1—3.*) Different stages of human spermatogenesis. *Fig. 4* shows several rows of spermatids recently formed by the division of spermatocytes of the second order; while in *Fig. 5* the beginning of their transformation into sperms may be recognized. The nuclei of the Sertoli cells have been pressed inward some distance from the nucleated sheaths of the tubules. **Technique:** Nitric acid-potassium bichromate. Paraffine. Haematoxylin-eosin.

bdm = connective tissue of the mediastinum testis
bg = blood vessels
corpep = body of epididymis
dd = ductus deferens
dep = sections through the ductus epididymidis
ep = epithelium
int = interstitial cells and connective tissue
knme = nuclei of the connective—tissue sheaths of the tubules
lt = lobules
me = connective—tissue sheaths of the seminiferous tubules

ret = rete testis
sept = septa
sert = nuclei of Sertoli cells
smep = sinus epididymidis
sp = spermatids
sp (Fig. 5) = spermatids in process of transformation
spc = spermatocytes
spc_1 = spermatocytes I
spc_2 = spermatocytes II
spg = spermatogonia
spz = sperms almost fully developed
talb = tunica albuginea
tubc = convoluted seminiferous tubules

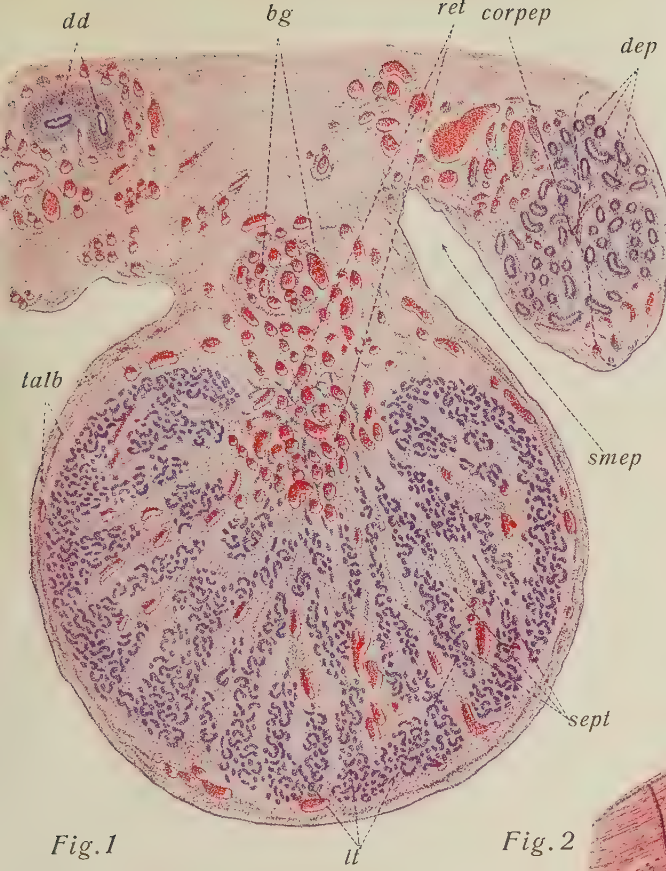

dd
bg
ret
corpep
dep
talb
smep
sept
lt

Fig. 1

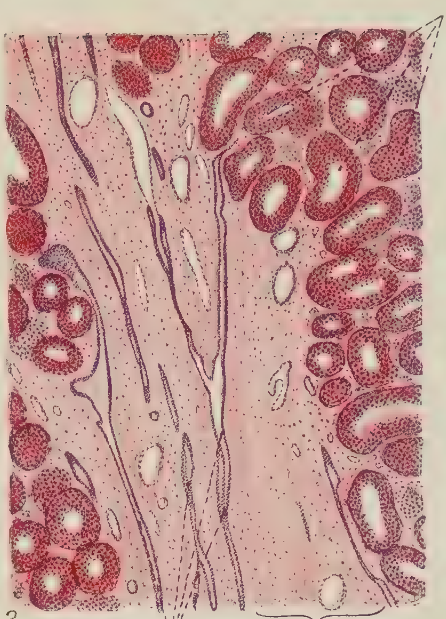

tubc
ret
bdm

Fig. 3

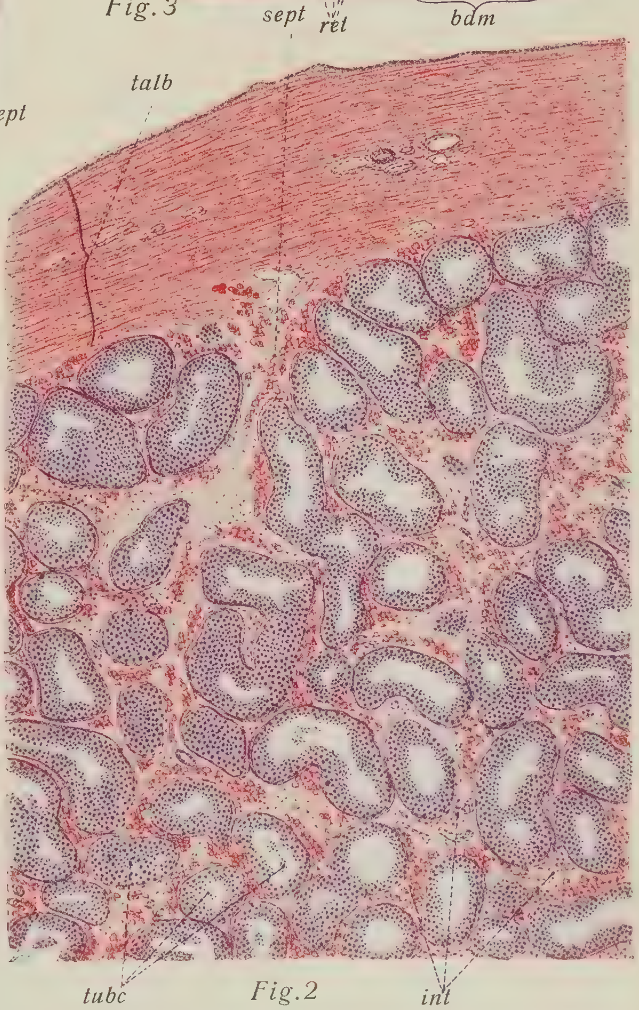

sept
talb
tubc
Fig. 2
int

Fig. 2

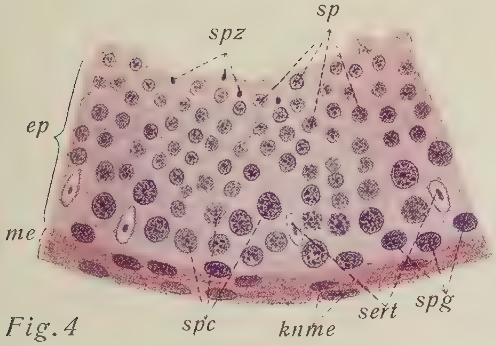

spz
sp
ep
me
spc
knme
sert
spg

Fig. 4

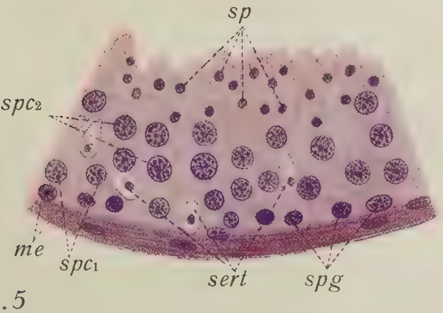

sp
spc_2
me
spc_1
sert
spg

Fig. 5

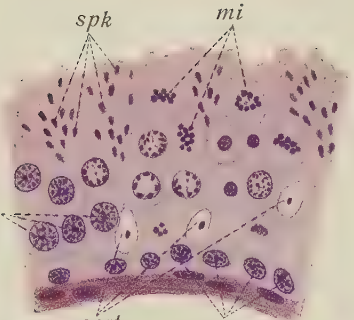
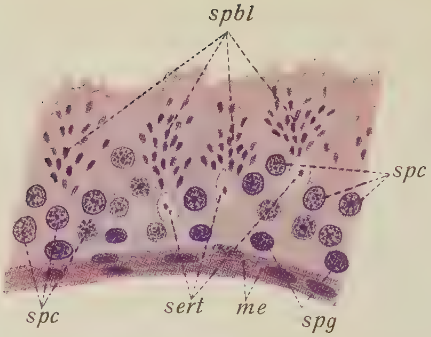

spk
mi
spc_1
sert
spg

Fig.2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spc
sert
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Fig.1

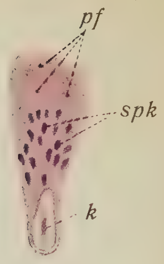

Fig.3

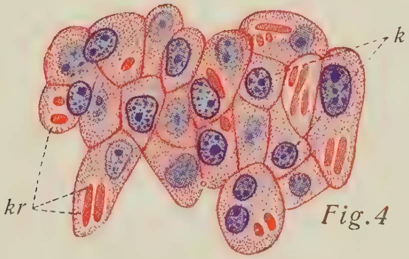

Fig.4

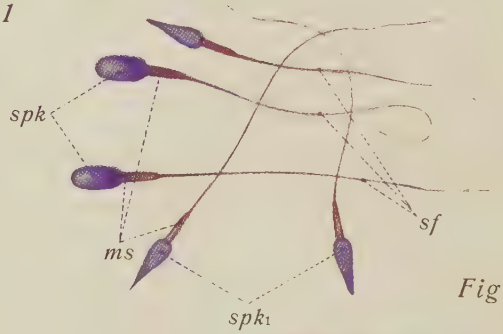
spk
sf
ms
spk_1

Fig.5

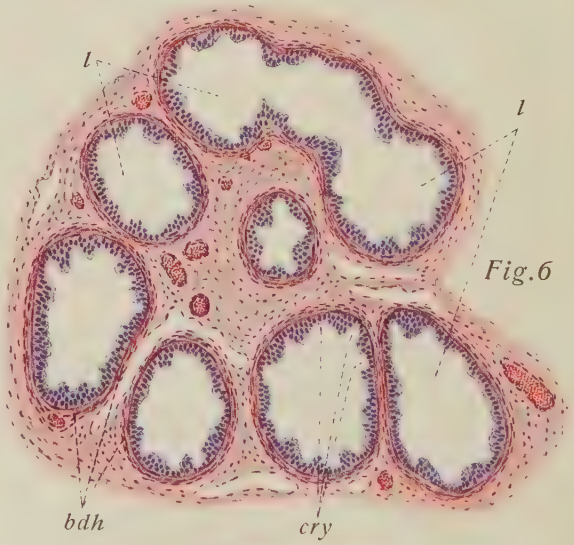

Fig.6

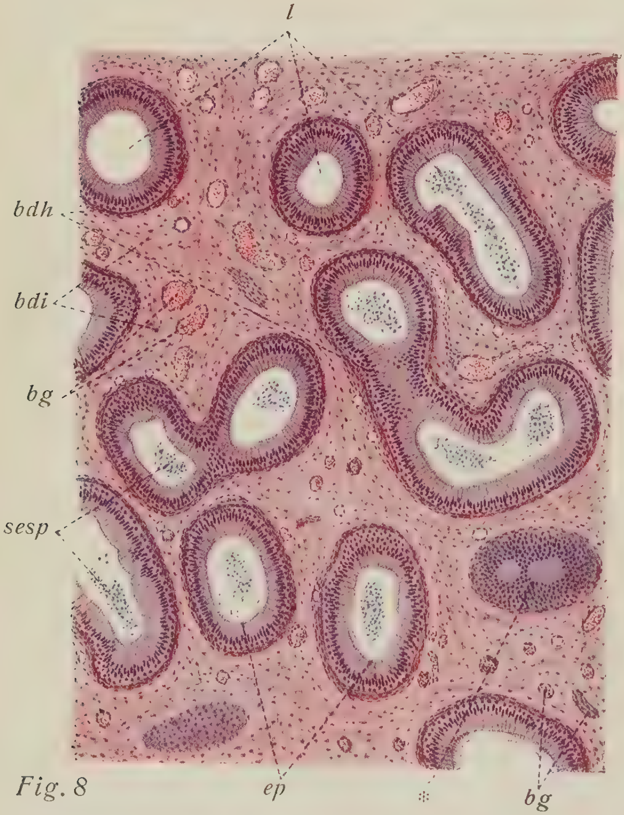
l
bdh
bdi
bg
sesp
ep
*
bg

Fig. 8

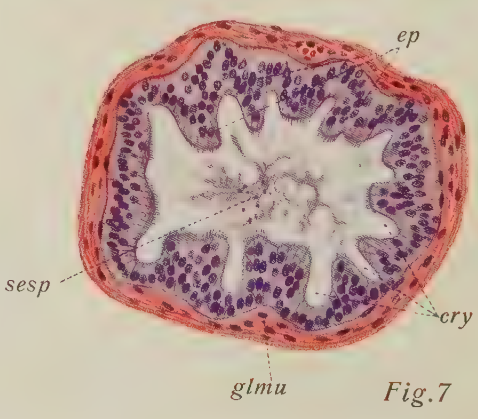
ep
sesp
cry
glmu

Fig.7

Plate 66. **Testis II, Epididymis.**

Figs. 1 and 2. Continuation of the Series of Pictures of **Spermatogenesis** in the Wall of the Seminiferous Tubules; cf. *Figs. 4 and 5*, Pl. 65. In *Fig. 1* fusion has been completed between the maturing sperms and the protoplasmic processes of the supporting cells of Sertoli; the nuclei of the latter lie some distance from the outer surface of the tubule. In *Fig. 2* separation of the ripe sperms has begun; nuclear mitosis is apparent in the spermatocytes. **Technique,** source, and magnification as for *Figs. 5 and 6*, Pl. 65.

Fig. 3. A **Spermatoblast** from the Epithelium of a Seminiferous Tubule. × **500.** The heads of the maturing sperms lie deep in the cytoplasm of the Sertoli cell almost reaching the nucleus. **Technique** and source as for *Figs. 5 and 6*, Pl. 65.

Fig. 4. A Group of **Interstitial Cells** (Leydig's Cells) **of the Testis** (Human, aet. 22. Execution). × **550.** The large epitheloid cells contain abundant cytoplasm and are occasionally binucleate; within their cytoplasm are peculiar crystalloids staining strongly with eosin. The cells also contain other inclusions (lipoids etc.) not visible in this preparation. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 5. **Human Sperms.** × **1050.** Typical flagellate cells. The flat ellipsoidal head consists essentially of concentrated chromatin; then follow the much narrower middle-piece and the long, slender, and contractile, threadlike tail. Some of the heads are seen from the surface and others from the side; it is evident that they are pointed in front and thicker posteriorly. **Technique:** Cover-glass preparation, dried. Haematoxylin-eosin.

Fig. 6. A Section through a **Lobule of the Head of the Epididymis** (Human, aet. 22. Execution). × **80.** General view of the ductuli efferentes testis. The tubules show irregular contours, wide lumina, connective-tissue sheaths and usually a simple epithelium which contains peculiar depressions. **Technique** and source as for *Fig. 4.*

Fig. 7. Transverse Section of a **Ductulus Efferens Testis.** × **175.** Ridges of ciliated epithelium alternate with cryptlike depressions in which cilia are lacking. In the interior are masses of secretion and sperms. **Technique** etc. as for *Fig. 4.*

Fig. 8. Part of a Transverse Section of the **Body of a Human Epididymis.** × **80.** The section has cut many times across the much convoluted **ductus epididymidis.** The lumina are large and wide open and being filled with masses of sperms serve as a receptaculum seminis. The epithelial cells are in two rows, basal and superficial; in the latter they are very long and columnar and have stereocilia (Pl. 3, *Fig. 4*). The epithelium rests upon a wall of connective tissue which in the tail of the epididymis is gradually supplemented by smooth muscle. **Technique** etc. as for *Fig. 4.*

bdh = connective-tissue sheaths
bdi = interstitial connective tissue
bg = blood vessels
cry = crypts
ep = epithelium
glmu = smooth muscle
k = nuclei
kr = crystalloids
l = lumen
me = connective-tissue sheath of seminiferous tubule
mi = mitotic division in spermatocytes
ms = middle pieces of sperms

pf = protoplasmic processes of the Sertoli cel
sert = sustentacular cells of Sertoli
spbl = spermatoblasts
spc = spermatocytes
spc_1 = spermatocytes I
spg = spermatogonia
spk = heads of sperms
spk_1 = the same in profile
sesp = secretion containing sperms
sf = tails of sperms
* = tangential section of the ductus epididymidis

Plate 67. **Spermatic Cord, Ductus deferens I.**

Fig. 1. Transverse Section of a **Spermatic Cord** (Human, aet. 22. Execution). × **12.** General view of the contents of a spermatic cord the sheaths of which have been almost completely removed. On the left is the cross section of the ductus deferens with its own blood vessels: elsewhere are numerous sections of the spermatic vessels, particularly of the veins of the pampiniform plexus with their unusually muscular walls. All the foregoing structures along with considerable adipose tissue are embedded in connective tissue. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Transverse Section of a Human **Ductus Deferens.** × **53.** The figure shows again the part of the ductus deferens which is contained in the spermatic cord (*Fig. 1*). A glance shows the striking contrast between the narrow lumen surrounded by the thin mucous coat and the heavy wall of muscle. The mucous membrane bears a ciliated epithelium and is thrown into low longitudinal folds. It is entirely devoid of glands and rests directly upon the extremely thick muscular coat. The layers of the muscular coat are never quite regular and vary in the different parts of the ductus deferens (cf. *Fig. 1*, Pl. 68). In this section there may be distinguished three layers of which the middle is circular while the inner and outer run longitudinally. Quite externally is seen adventitious connective tissue in which are numerous vessels, nerves and even sympathetic ganglia. **Technique** and source as for *Fig. 1.*

Fig. 3. **Mucous Membrane** from a Transverse Section of a Human **Ductus Deferens.** × **140.** The longitudinal folds are cut across. The ciliated epithelium consists of two layers of cells. The tunica propria shows no glands or other peculiarities. **Technique** etc. as for *Fig. 1.*

adv = adventitious connective tissue
art = arteries
alm = external longitudinal muscle
bg = blood vessels
ep = epithelium
fe = adipose tissue

ilm = inner longitudinal muscle
l = lumen
rm = circular muscle
tp = tunica propria
vd = vessels of the ductus deferens
ve = veins

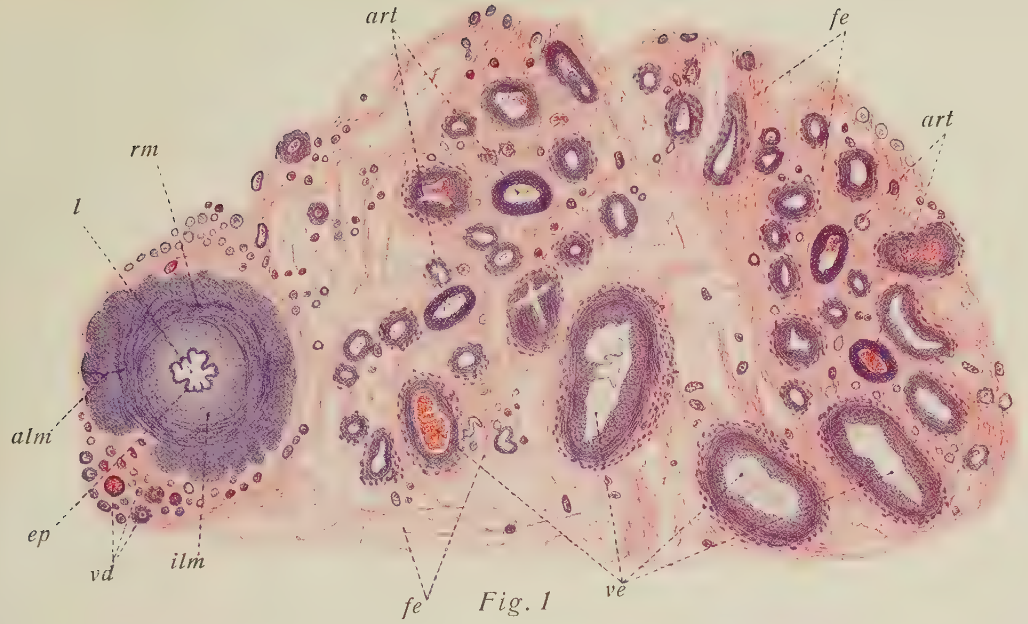
art
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Fig. 1

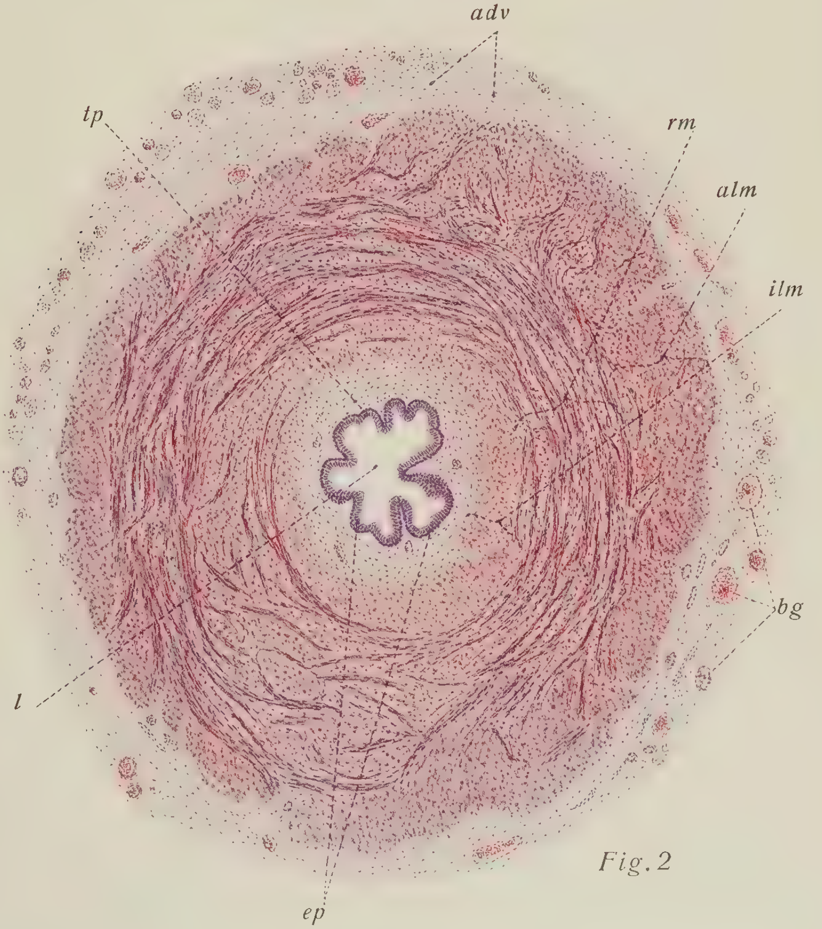
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Fig. 2

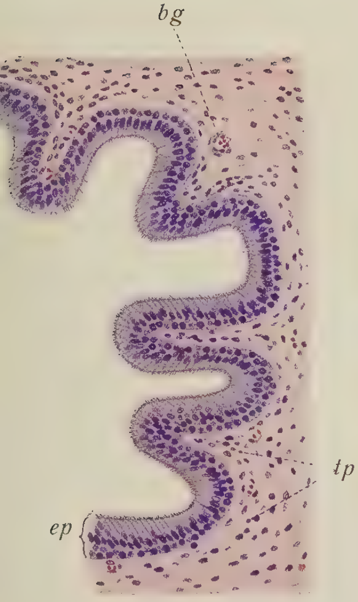
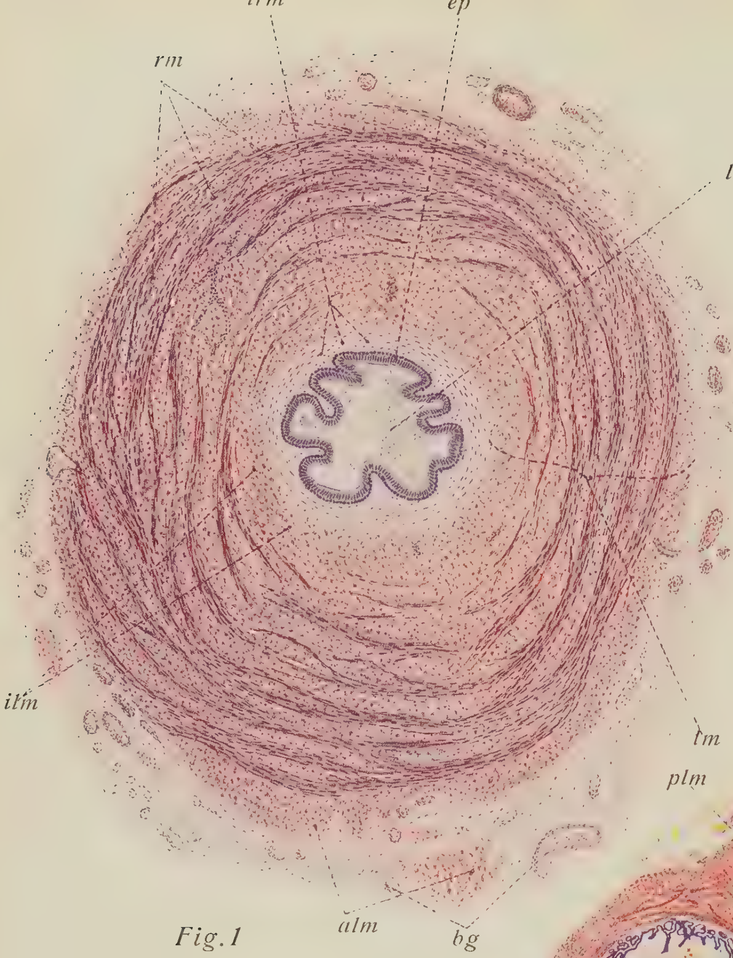


Fig. 3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itm
tm
alm
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Fig.1

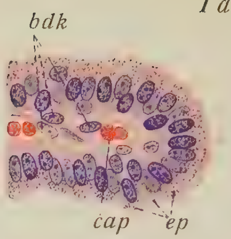
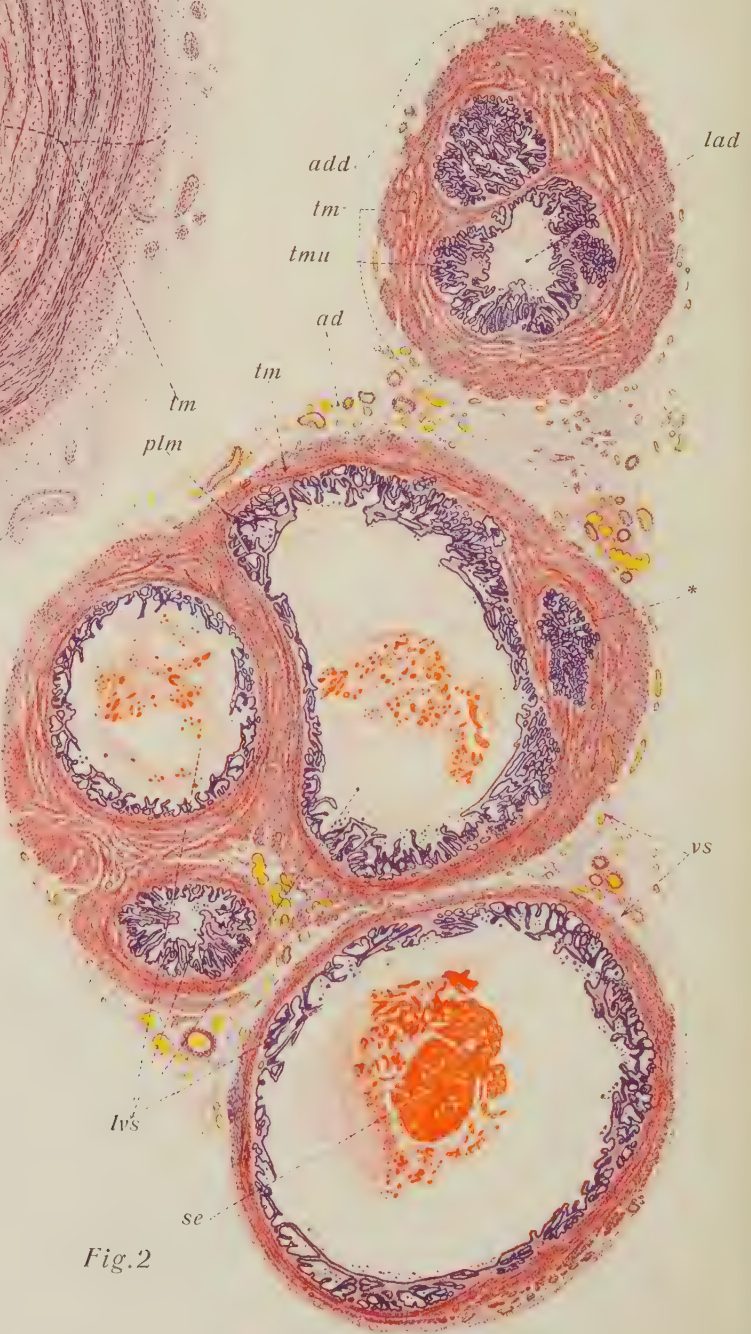


Fig.4


add
lad
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*
vs
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Fig.2

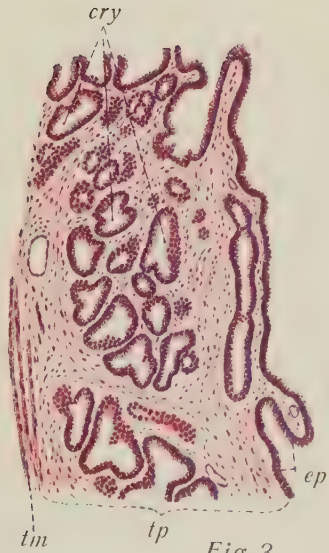

Fig.3

Plate 68. **Ductus Deferens II, Seminal Vesicle.**

Fig. 1. Transverse Section through the Pelvic Portion of the **Ductus Deferens** (Human, aet. 28. Execution). × **28.** General view; compare *Fig. 3*, Pl. 67. The pelvic part of the duct is much more muscular than the part which lies in the spermatic cord. The subdivision of the muscle is also different, in particular there appears an inner layer of circular muscle lying immediately beneath the mucous membrane; the layers in the remaining, and principal, part of the muscular coat are irregular. Sperms are seen in the lumen. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Transverse Section through the **Seminal Vesicle** and through the **Ampulla of the Ductus Deferens** (Human, aet. 21. Execution). × **10.** General view. The ampulla is above while below are several sections of the seminal vesicle, the convolutions of which are closely pressed together. The lumen of the vesicle appears to vary in width and contains considerable secretion which occurs partly as fine and partly as coarse rounded masses. Note the abundance of folds in the mucous membrane and how it forms pockets which are almost as marked in the ampulla as in the seminal vesicle. They stand out particularly well in tangential sections of the wall. Beside the moderately strong muscular coat with its rather irregular layers there is an adventitia of connective tissue rich in vessels and nerves. **Technique** as for *Fig. 1.*

Fig. 3. **Mucous Membrane** of the Human **Seminal Vesicle.** × **56.** Note the folds of the mucous membrane and the cryptlike pockets formed by their anastomoses. They are covered by a simple columnar epithelium. **Technique** and source as for *Fig. 1.*

Fig. 4. The Crest of a **Fold of Mucous Membrane** from a Human **Seminal Vesicle.** × **485.** A simple columnar epithelium covers a thin layer of connective tissue containing capillaries. Numerous brown pigment granules are seen in the epithelium.

ad = adventitious connective tissue
add = ampulla ductus deferentis
alm = external longitudinal muscle
bdk = nuclei of connective tissue
bg = blood vessels
cap = capillary
cry = crypts in mucous membrane
ep = epithelium
ilm = inner longitudinal muscle
irm = inner circular muscle
l = lumen
lad = lumen of ampulla
lvs = lumen of seminal vesicle
plm = folds of mucous membrane
se = secretion
tm = muscular coat
tmu = mucous coat
tp = tunica propria
vs = seminal vesicle
* = tangential section of wall of seminal vesicle

Plate 69. **Urethra, Penis.**

Fig. 1. Transverse Section of the **Pars Membranacea of the Male Urethra** (Human, aet. 21. Execution). × **24.** This part of the urethra, which is enclosed neither in the tissue of the prostate gland nor in the corpus spongiosum, possesses a strong wall of its own consisting of smooth muscle. The mucous membrane shows many folds and is rich in blood vessels but relatively poor in glandular structures which are to be found only in its external parts, or even between the adjacent bundles of muscle, and are parts of the large glands of this portion of the urethra. The muscular coat consists of circular and longitudinal bundles of smooth muscle arranged in irregular layers. **Technique:** Müller's fluid–formol. Celloidin. Haematoxylin-eosin.

Fig. 2. Mucous Membrane of the **Pars Membranacea of a Male Urethra.** × **60.** The whole thickness of the mucous membrane is displayed and beneath it the superficial strands of smooth muscle. The mucous membrane shows folds and pockets and is covered by a columnar epithelium of two layers of cells. The wealth of veins in the tunica propria is striking. **Technique** and source as for *Fig. 1.*

Fig. 3. Transverse Section of a **Penis** (**Human,** aet. 22. Execution). × **3¼**. General view. The cavernous spaces are empty and collapsed, and as a result the tunica albuginea which surrounds each corpus cavernosum is especially thick and dense. The corpus spongiosum (corpus cavernosum urethrae) has no such tunic; it contains the flattened lumen of the urethra. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 4. Transverse Section of a **Human Corpus Cavernosum Urethrae with the Pars Cavernosa Urethrae.** × **15.** The cavernous spaces are relatively empty and contain only a little blood. Beside trabeculae of connective tissue a few bundles of smooth muscle occur in the cavernous tissue. The lumen is flattened and shows distinct evaginations, the lacunae of Morgagni. The epithelium is stratified and already in places has assumed the character of stratified squamous epithelium. The glands are few in number and show many clear terminal parts which are secreting mucous. They are not at all confined to the tunica propria but extend in places quite deeply into the cavernous tissue. **Technique** and source as for *Fig. 3.*

adp = dorsal artery of penis
alb = tunica albuginea
app = deep artery of penis
art = arteries
bg = blood vessels
cacu = corpus cavernosum urethrae (corpus spongiosum)
ccap = corpus cavernosum penis
ep = epithelium
ep (Fig. 3) = epidermis
epur = epithelium of urethra
glur = urethral glands (of Littré)
glur (Fig. 1) = bulbo-urethral glands (of Cowper)
glse = sebaceous glands in skin of penis
l = lumen
lb = depression in the lumen of the urethra (lacunae of Morgagni)
lm = bundles of longitudinal muscle
mb = bundles of smooth muscle in the corpus spongiosum
mu = smooth muscle
n = nerves
rm = circular muscle
sp = septum penis
spc = cavernous sinuses of the corpus cavernosum urethrae
tp = tunica propria
vdp = dorsal vein of penis

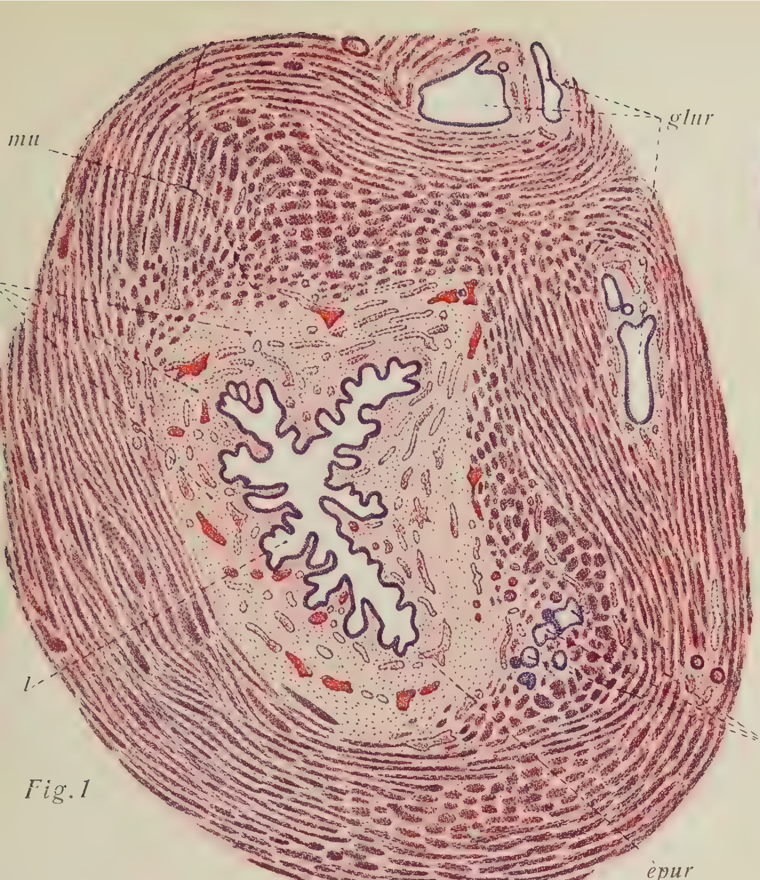
mu
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Fig.1

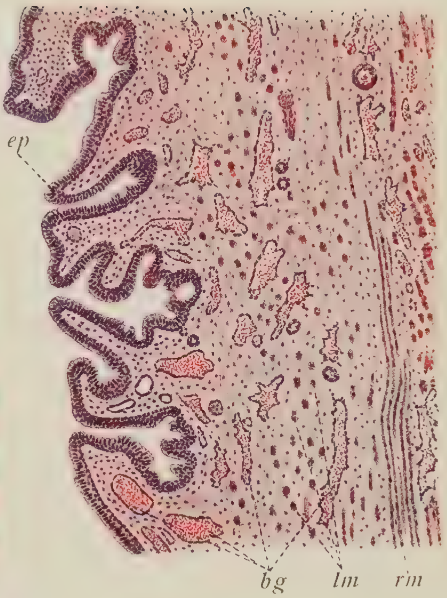

Fig.2

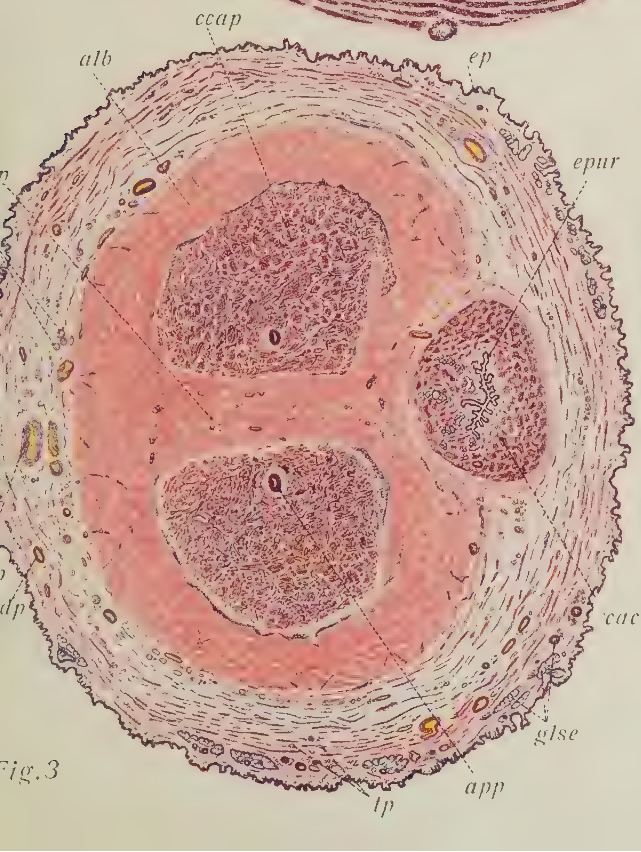
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Fig.3

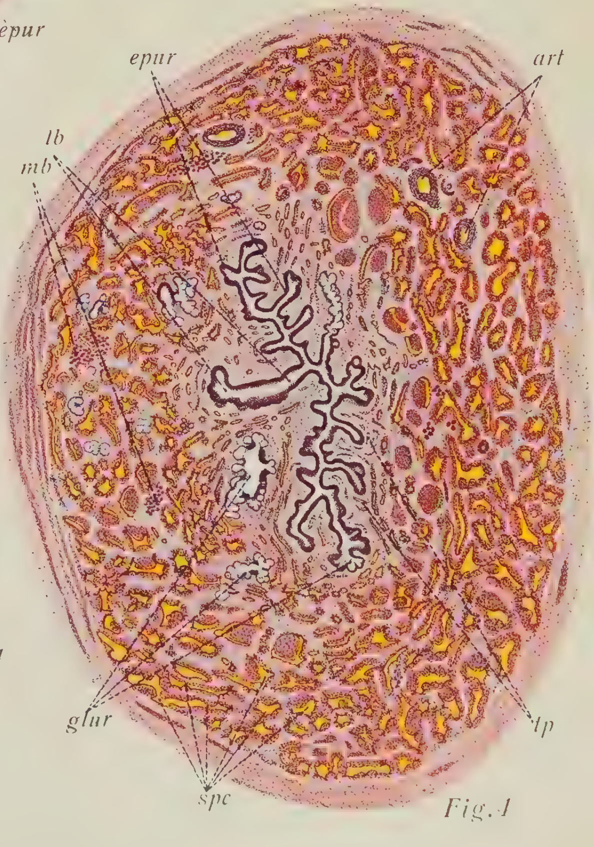
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Fig.4

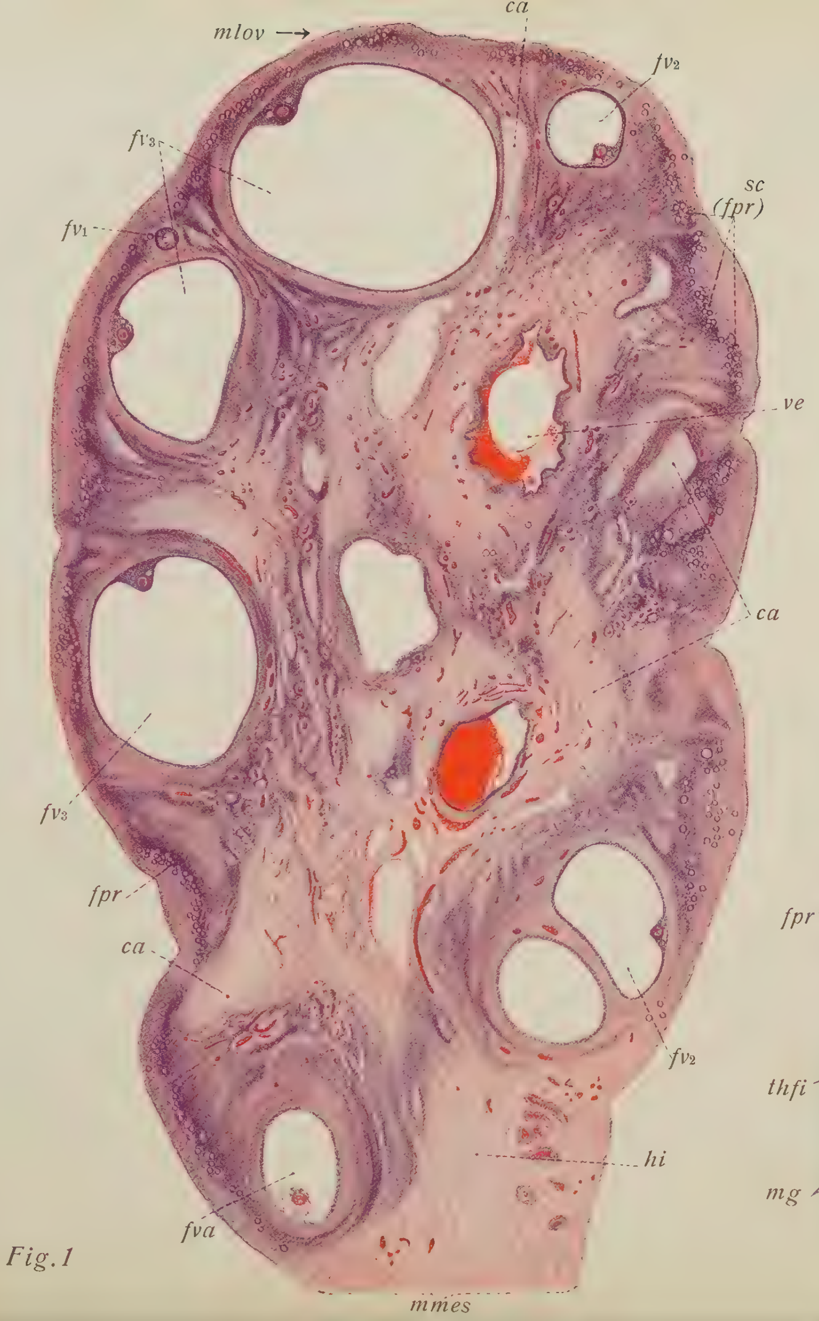
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Fig. 1

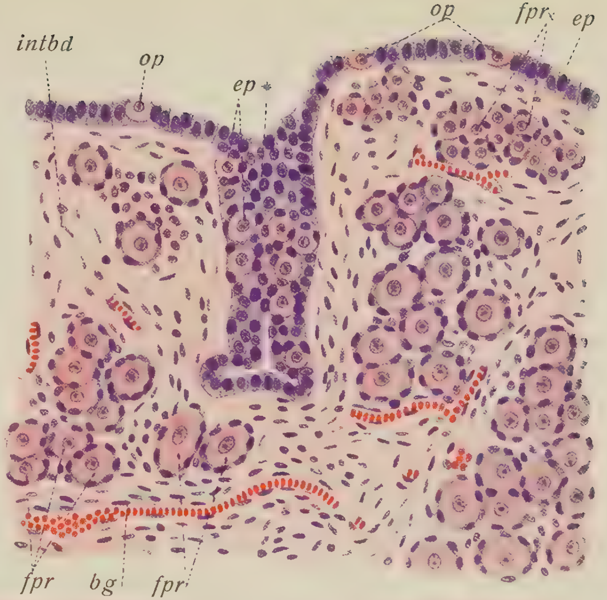
intbd
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Fig. 2

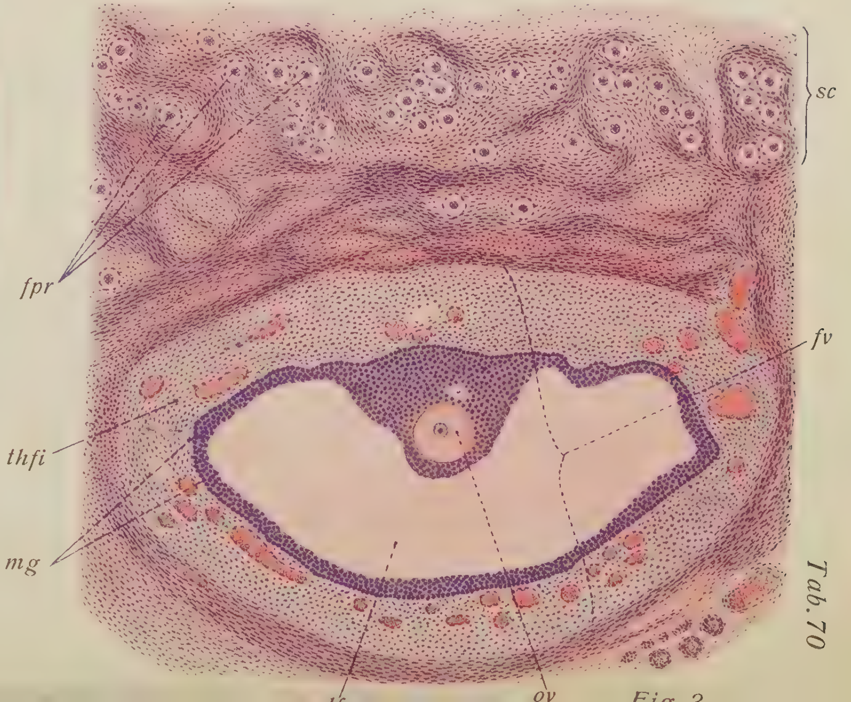
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Fig. 3

Plate 70. **Ovary I.**

Fig. 1. A Section of an **Ovary** (**Woman,** aet. 28). × **10.** General view of the ovary at its fullest development. The free surface is above while the mesovarium is cut off short at the bottom of the figure. The cortex is broad; beside numerous primary follicles in different stages of formation it shows also Graafian follicles, a number of which have reached a very considerable size. In addition there is seen an atretic follicle (below at the left), corpora albicantia, *i.e.* the remains of corpora lutea, and scarlike depressions of the surface of the ovary marking the positions of former corpora lutea. In the medulla are large blood vessels many of which are empty or even collapsed. **Technique:** Picro-sublimate. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of the Cortex of an **Ovary** (Newborn Child). × **280.** On the surface is the germinal epithelium, a simple, cubical epithelium among the cells of which are seen a few larger, rounded elements, the primitive ova. A cord of cells derived from the germinal epithelium, the so-called egg-tube of Pflüger, has grown inward and shows the beginning of the process by which its primitive ova and cells from the germinal epithelium are formed into primary follicles. Beneath the germinal epithelium are groups of primary follicles of different sizes. **Technique:** Müller's fluid. Paraffine. Haematoxylin-eosin.

Fig. 3. Part of a Section of an **Ovary** (Girl, aet. 15). × **15.** Beneath the albuginea, embedded in connective tissue, are seen a number of primary follicles, and still deeper is a vesicular (Graafian) follicle of medium size. Note its content of fluid, the mass of epithelium in which the ovum is situated, and the theca of connective tissue, the inner layer of which is rich in cells and in this section is especially broad. **Technique:** (Fixation etc. unknown). Haematoxylin-eosin.

ca = corpus albicans
bg = blood vessel
ep = germinal epithelium
fpr = primary follicles
fv = vesicular follicle
fv_1 = early stage of vesicular follicle
fv_2 = middle stage of vesicular follicle
fv_3 = advanced stage of vesicular follicle
fva = atretic follicle
hi = hilus ovarii
intbd = interstitial connective tissue

lf = liquor folliculi
mg = membrana granulosa (follicular epithelium)
mlov = free border of ovary
mmes = mesovarian border of ovary
op = primary oocytes
ov = ovulum
sc = cortex
thfi = inner layer of the theca folliculi
ve = vein
* = depression opposite Pflüger's egg-tube

Plate 71. **Ovary II.**

Fig. 1. The **Ovum** of the Follicle Pictured in *Fig. 3*, Pl. 70 with the Surrounding Cumulus Oöphorus. × **550.** The ovum (oöcyte I) has a slightly eccentric nucleus (germinal vesicle); within which is a distinct nucleolus (germinal spot). Outside of the oölemma some of the epithelial cells of the discus show mitoses. **Technique** as for *Fig. 2*, Pl. 70.

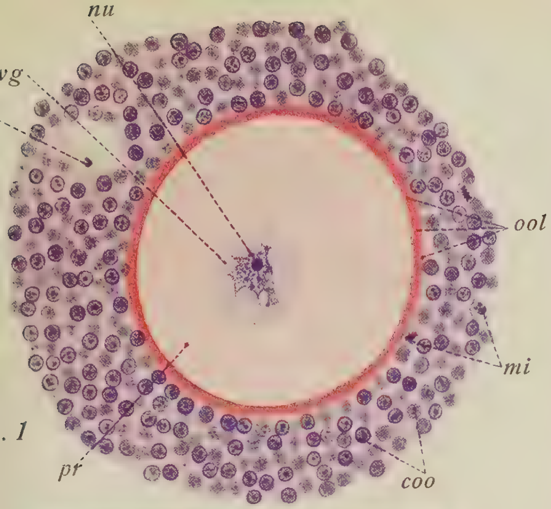
Fig. 2. A Very Small **Graafian Follicle** from the Ovarian Cortex (Human, aet. 28. Operation). × **225.** The follicular epithelium already consists of several layers of cells and contains mitoses, but formation of the liquor folliculi has not yet begun. **Technique:** Formol-picro-sublimate. Celloidin. Haematoxylin-eosin.

Fig. 3. Small **Graafian Follicle** (Human, aet. 28. Operation). × **75.** Some follicular fluid has already appeared and the theca folliculi is distinctly formed. This follicle in its development lies midway between the follicles of *Figs. 2* and *4*.

Fig. 4. Part of a Section of an **Ovary** (Human, aet. 28. Operation). × **100.** There is seen a Graafian follicle of medium size with a rather large antrum. In the epithelium are Call-Exner bodies. The theca folliculi is very distinct; its inner layer with large cells and numerous vessels (theca interna) can be distinguished from the outer layer with its abundant fibers (theca externa). **Technique** as for *Fig. 2*.

Fig. 5. **A Follicle Discharging Its Ovum** (Ovary of **Guinea-pig**). × **60.** The contents of the follicle, both ovum and liquor folliculi, are flowing out through the tear in its wall. Numerous cells of the follicular epithelium are escaping, some of them are scattered through the liquor. The follicle itself is much collapsed. Since the oöcyte is undergoing a maturation division it contains no nucleus. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

coo = cumulus oöphorus
fp = primary follicles
fep = follicular epithelium
fep$_1$ = follicular epithelium of the cumulus ovigerus
kep = germinal epithelium
l = leucocyte
lfo = liquor folliculi
lfo$_1$ = liquor remaining in the ruptured follicle
lfo$_2$ = liquor discharged along with the ovum
mi = mitoses
mp = membrana propria
nu = nucleolus
ool = oölemma (zona pellucida)
ov = ovulum
pr = protoplasm (cytoplasm) of the oöcyte
thf = theca folliculi
thfe = outer layer of theca
thfi = inner layer of theca
vg = germinal vesicle
* = Call-Exner bodies
** = point of rupture of follicle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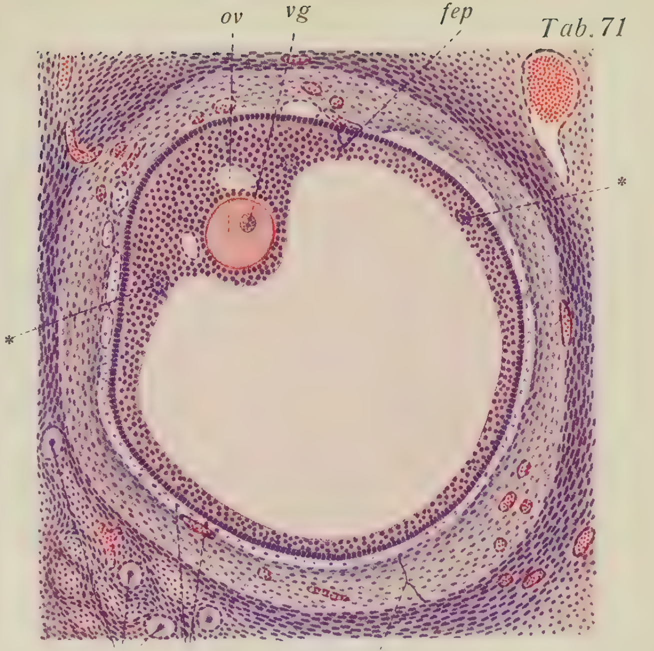
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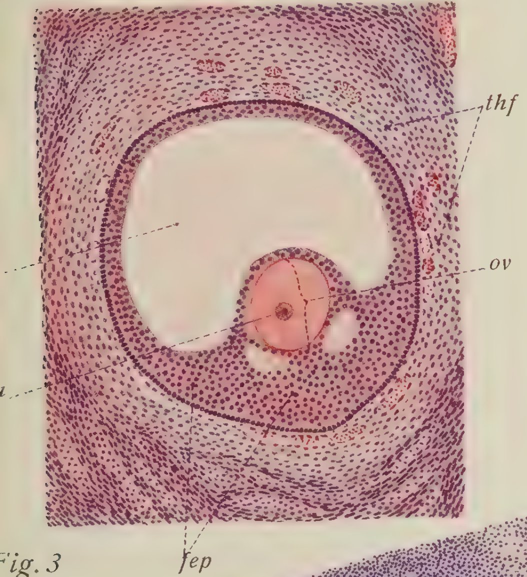
Fig. 4



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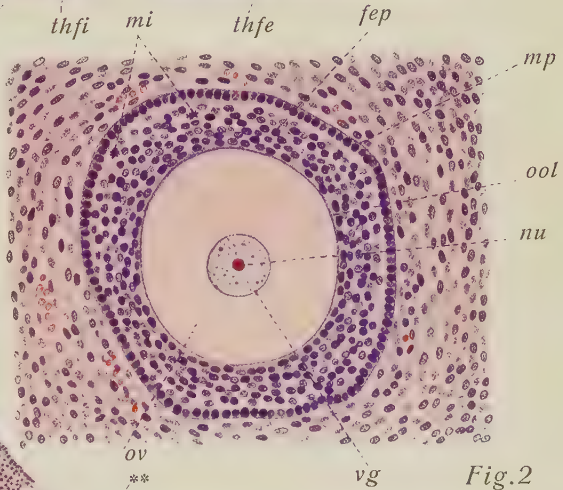
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Fig. 2

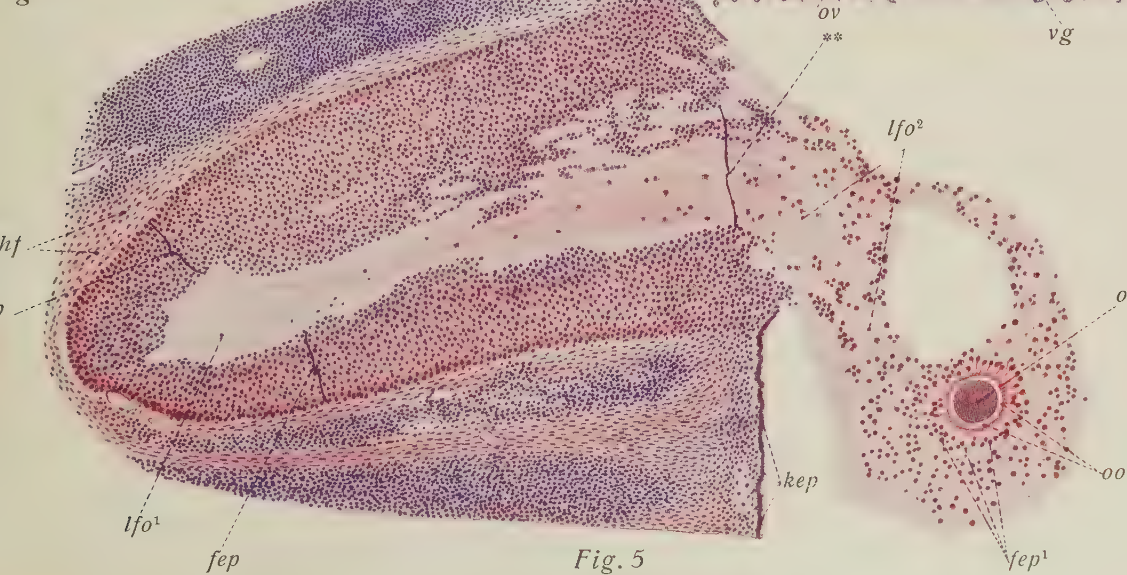
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Fig. 5

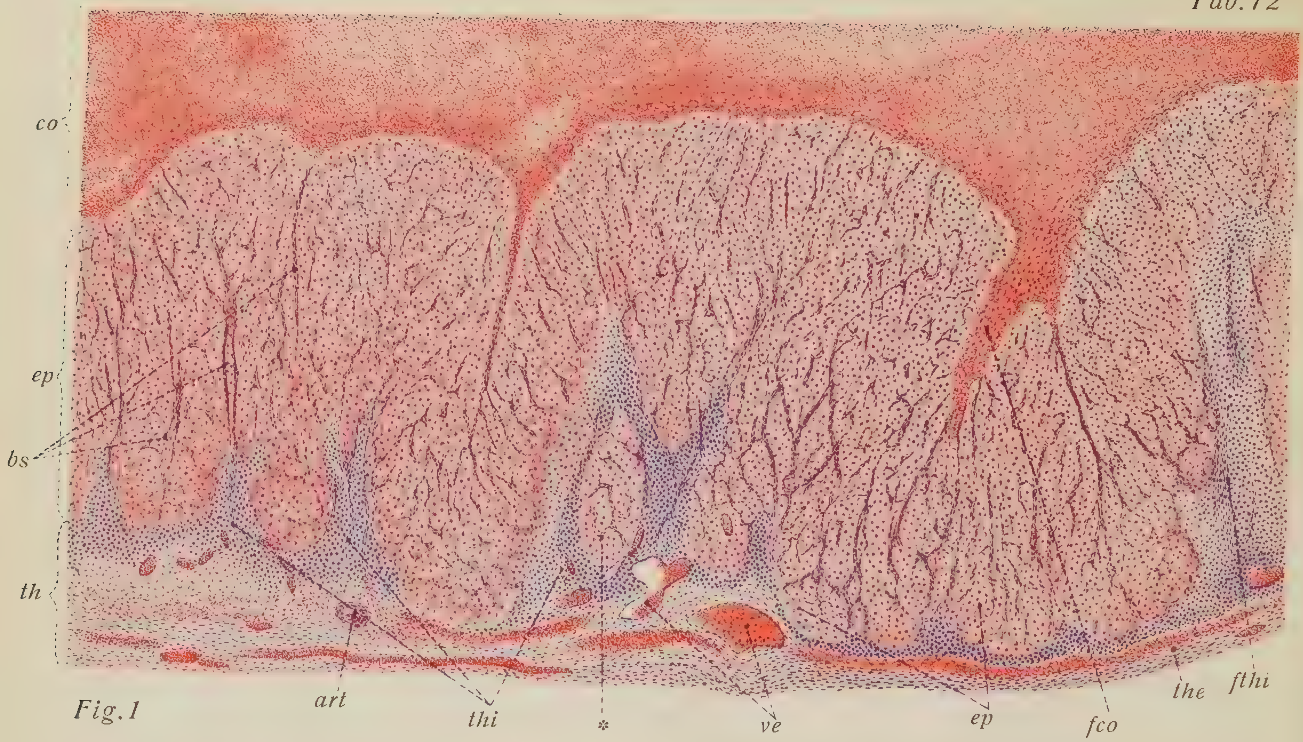
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Fig. 1

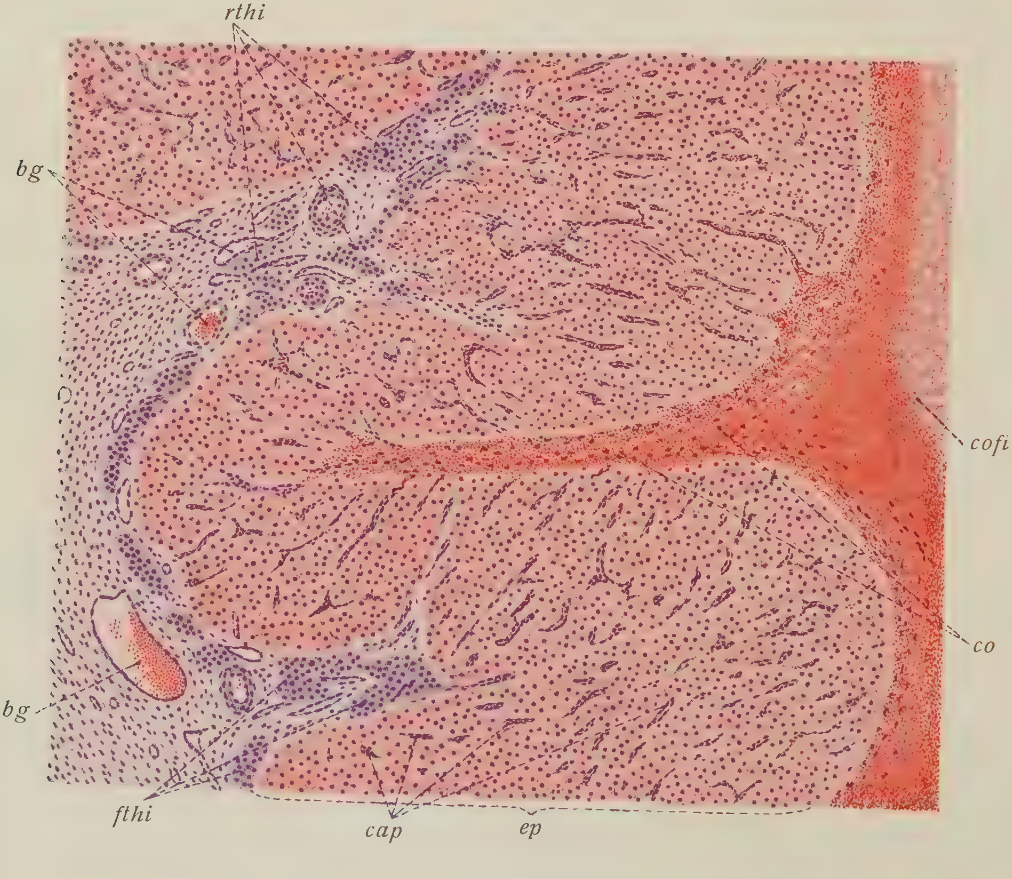
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Fig. 2

Plate 72. **Ovary III (Corpus luteum).**

Fig. 1. Part of a Section through a Relatively **Young Corpus Luteum** (Menstruationis). × **43.** From an ovary obtained at an operation upon an adult woman. Above is the central coagulum with red blood corpuscles still for the most part intact. Beneath it is the folded hypertrophic-hyperplastic epithelial wall of the corpus luteum into which thin processes of the coagulum extend from above; while from the outer side (below) processes of the theca interna containing many cells penetrate the folded epithelial wall. At the bottom of the figure are large blood vessels and the fibrous theca externa. Numerous slender strands of connective tissue bearing capillaries traverse the epithelial wall. The deep folds of the epithelial wall cause even perpendicular sections through the middle of the corpus luteum to cut the wall tangentially (as at *). The figure gives a general view of the formation of the corpus luteum resulting from the rupture of a follicle. **Technique:** Formol-picro-sublimate. Celloidin. Haemalum-eosin.

Fig. 2. Part of a Section of a **Corpus Luteum** (Menstruationis) of an Adult Woman (Operation). × **70.** The corpus luteum is somewhat older than that pictured in *Fig. 1.* Its external wall is at the left, the central cavity with the blood clot is on the right. The clot has already begun to change, some of the red blood corpuscles have already broken up and many leucocytes are in the part which projects into the epithelial wall. The epithelial layer of the wall of the corpus luteum is clearly seen to be composed of large cells with abundant protoplasm, the so-called epithelial lutein cells, among which are capillaries in fine strands of connective tissue derived from the theca. The structure of the theca is displayed with unusual clearness. It shows compact groups of connective-tissue cells, rich in protoplasm, the so-called theca lutein cells, lying in a highly cellular fibrous connective tissue which also contains the larger blood vessels. The theca lutein cells take no part in forming the epithelial wall proper of the corpus luteum; however they are especially abundant in the processes which the theca sends into the folded epithelial wall; and which indeed are the cause of the folds. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

art = artery
bg = blood vessels
bs = connective-tissue septa
cap = capillaries
co = blood clot
cofi = coagulum of fibrin
ep = epithelium (lutein cells forming wall)
fco = projection from clot into the epithelial wall
fthi = projections from the theca interna into the epithelial wall
rthi = groups of cells of the theca interna
th = theca
the = theca externa
thi = theca interna
ve = veins
* = epithelial wall cut tangentially

Plate 73. **Oviduct.**

Fig. 1. Transverse Section of the **Ampulla of a Human Oviduct. × 22.** General view. Note how the wide lumen is almost converted into a labyrinth by the numerous and highly branched folds of the mucous membrane, which is quite devoid of glands. The muscular coat is relatively weak and is irregularly subdivided into layers, between the chief of which lie numerous large vessels. Externally the thin serous coat is seen. **Technique:** Zenker's fluid. Paraffine. Haemalum-eosin.

Fig. 2. A **Fold of Mucous Membrane from the Ampulla of a Human Oviduct. × 550.** The extremely thin layer of tunica propria consisting of a little connective tissue with capillaries is covered on both sides by a simple ciliated epithelium. Not all of the cells bear cilia, a few are distinctly granular near the free end and are secreting cells. In addition there are seen dying cells which are being extruded from the epithelium. **Technique** as for *Fig. 1.*

Fig. 3. Transverse Section through the **Isthmus of a Human Oviduct. × 20.** The folds of the mucous membrane are decidedly less numerous than in the ampulla and are less highly branched. As a result although the lumen is less in total diameter it is more open; however there is no true central opening. The muscular coat is much stouter than in the region of the ampulla, and where it touches upon the mesosalpinx it contains many large blood vessels. Externally the serous coat is seen. **Technique** as for *Fig. 1.*

Fig. 4. Transverse Section of the **Pars Uterina of a Human Oviduct. × 25.** In the middle is the narrow lumen, almost free from folds, surrounded by a relatively thin mucous membrane which contains numerous cells. Then follows the very strong muscular coat in which a rather compact inner layer of circular muscle is to be distinguished from an outer layer of longitudinal muscle. Between these two layers, at the attachment of the mesosalpinx, are sections of large blood vessels. The thin serosa forms the external coat. **Technique** as for *Fig. 1.*

art = arteries
bdk = nuclei of connective tissue
cap = capillary
ep = epithelium
ep_1 = dying cells being extruded from the epithelium
ep_2 = nuclei of the same
l = lumen
lm = longitudinal muscle

mes = mesosalpinx
plam = plicae ampullares
plim = plicae isthmicae
rm = circular muscle
tp = tunica propria
tpr = tunica propria
tse = serous coat
ven = veins

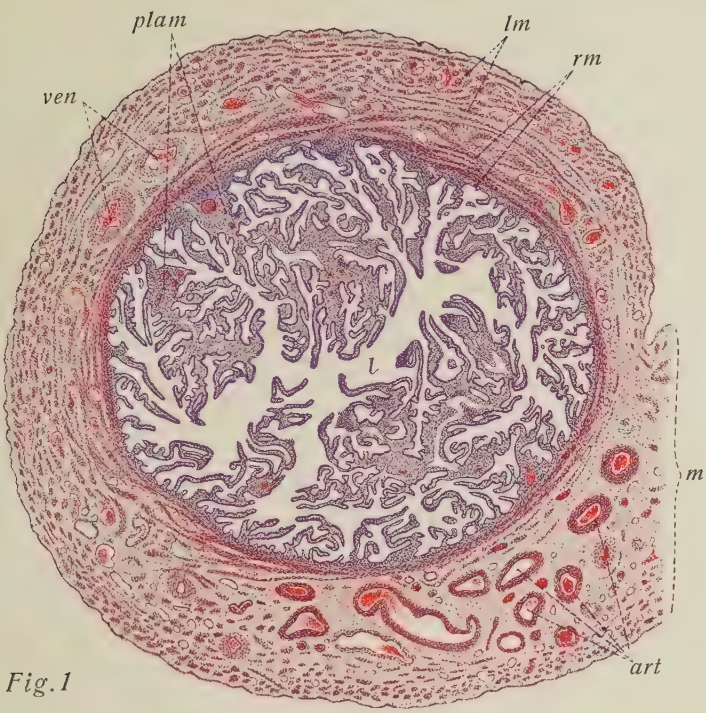
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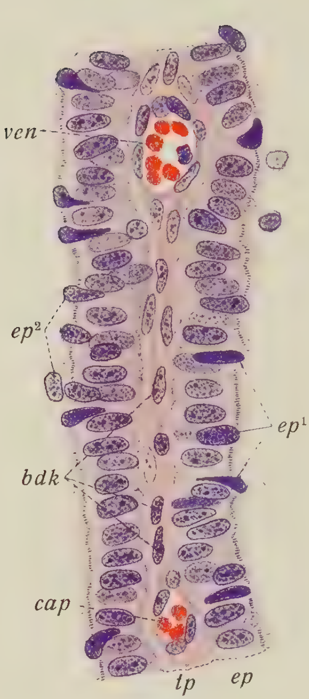
Fig.1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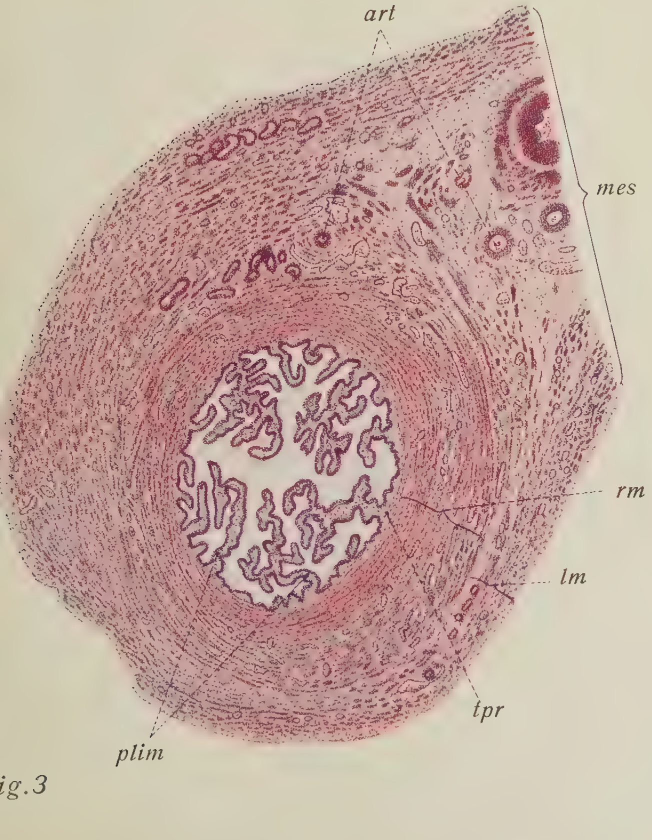
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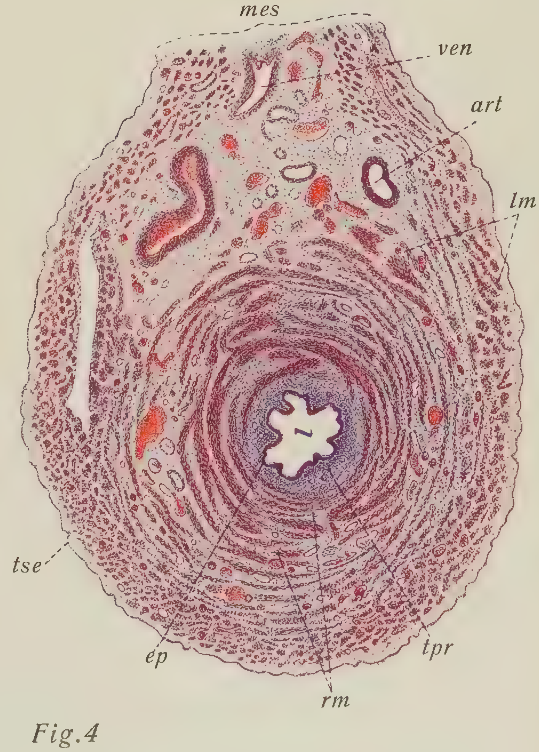
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Fig.4

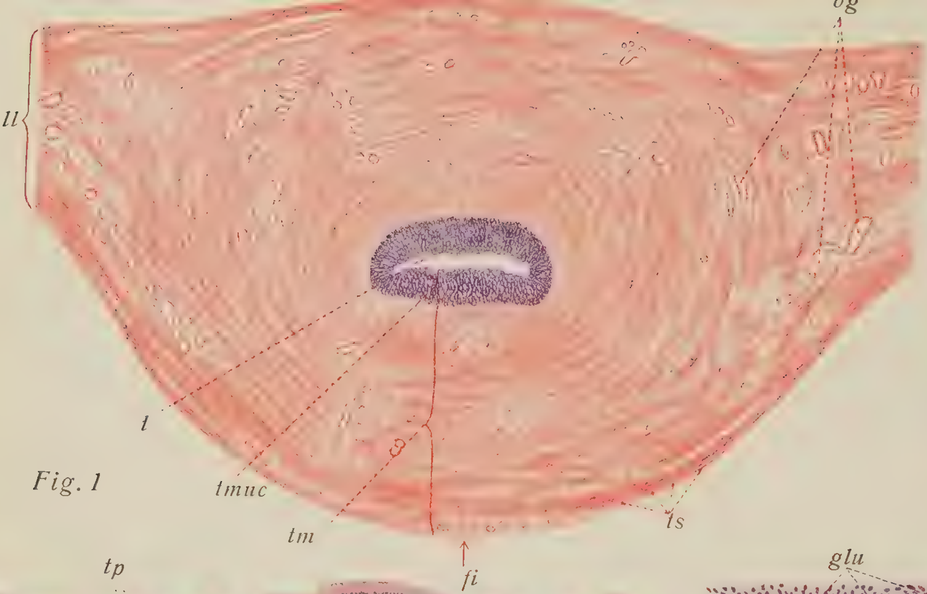
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Fig. 1

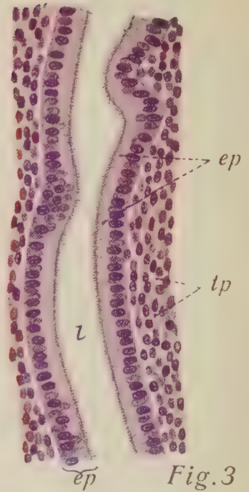
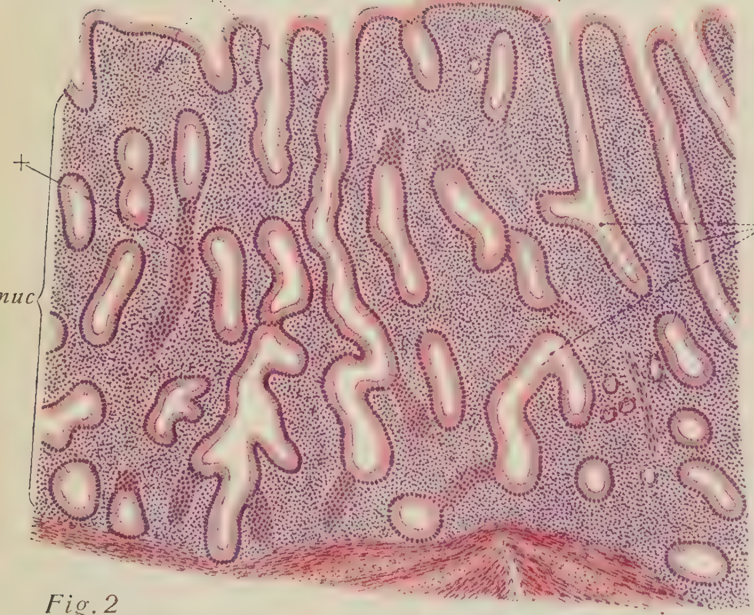


Fig. 3



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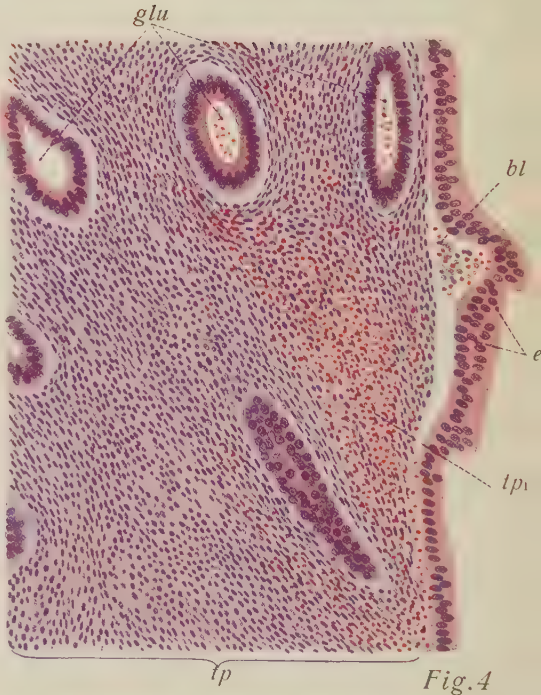
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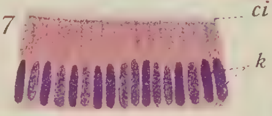
Fig. 4

Fig. 7



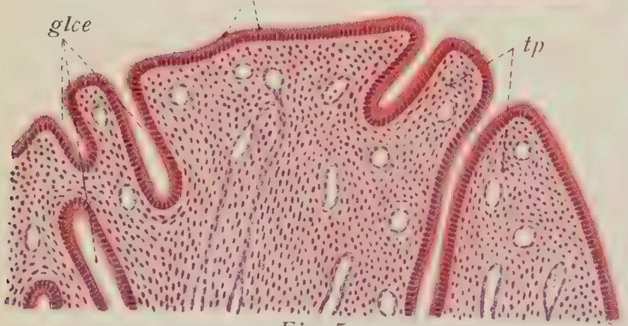


Fig. 5

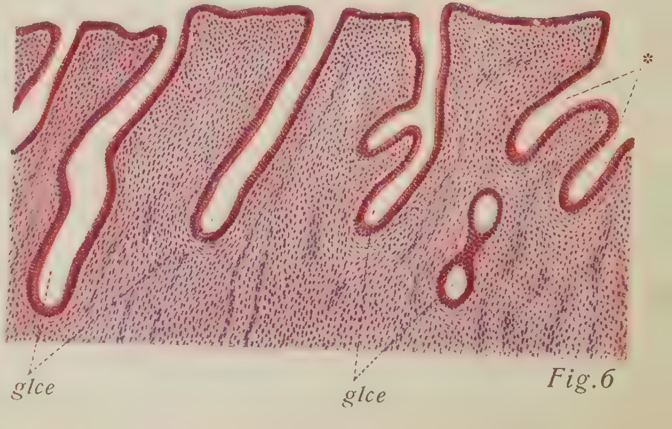


Fig. 6

Plate 74. **Uterus.**

Fig. 1. Transverse Section of the **Body of the Uterus** of an Adult Woman. × **2½.** General view of the coats of the uterine wall. In the center is the narrow lumen surrounded by the comparatively thin mucous membrane which contains numerous glands. Immediately next to this follows the extremely thick muscular coat. Laterally are seen the insertions of the broad ligament and externally the very thin serous coat. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. **Uterine Mucous Membrane** from a Transverse Section of a Uterus (Human, aet. 22). × **180.** The figure shows the structure of the mucous membrane from the body of the uterus. The membrane rests, as may be seen, upon the inner part of the muscular coat without the interposition of any submucous tissue whatever. The mucous coat consists of a tunica propria which is unusually rich in small lymphoid cells. A simple ciliated epithelium covers the surface and dips down to form the numerous glands which are much twisted and which penetrate the entire thickness of the mucous coat. **Technique** as for *Fig. 1.*

Fig. 3. Part of a Human **Uterine Gland.** × **300.** A gland from the body of the uterus. The epithelium bears cilia in all its extent to the very bottom of the gland so that — at least in human uteri — there is no question of secretion from these glands. **Technique** as for *Fig. 1.*

Fig. 4. Superficial Layer of the **Uterine Mucous Membrane** at the Beginning of **Menstruation** (Human, Adult). × **250.** Numerous free red blood corpuscles are to be seen in the superficial layers of the tunica propria and also beneath the epithelium which is distinctly raised away from the underlying connective tissue. The cilia of the epithelium have not been preserved. **Technique** as for *Fig. 1.*

Fig. 5. Superficial Layer of the **Mucous Membrane of the Cervix Uteri.** × **150.** There is seen the superficial epithelium and also the adjacent part of the tunica propria which here is less cellular than it is in the body of the uterus; lymphoid cells in particular are few in number. The mouths of a few cervical glands are shown. **Technique** etc. as for *Fig. 1.*

Fig. 6. **Cervical Mucous Membrane** from the Uterus of an Adult Woman. × **80.** Only about half the thickness of the mucous membrane is represented. Note the width of the lumina of the cervical glands, which are fewer in number than in the mucous membrane of the body of the uterus. The ciliated epithelium of the surface quickly passes into non-ciliated, secreting epithelium. **Technique** as for *Fig. 1.*

Fig. 7. **Epithelium from the Human Cervix Uteri.** × **500.** A simple ciliated epithelium like that of the corpus uteri, but of considerably higher (high columnar) cells. **Technique** as for *Fig. 1.*

bg = blood vessels
bl = blood
ci = cilia
ep = epithelium
fi = facies intestinalis uteri
fv = facies vesicalis uteri
glce = cervical glands
glu = uterine glands
k = nuclei

l = lumen
ll = attachment of broad ligament
tm = muscular coat
tmuc = mucous coat
tp = tunica propria
tp_1 = tunica propria and blood
ts = serous coat
+ = tangential section of uterine gland
* = opening of cervical glands into the lumen

Plate 75. **Vagina, External Female Genitalia.**

Fig. 1. A Section Perpendicular to the Upper Part of the **Vaginal Wall** (Human, aet. 28. Operation). × **25.** General view of the structure of the vaginal wall. Above is the heavy stratified squamous epithelium with papillae, some of which are very high; while beneath it is seen the thick tunica propria with abundant blood vessels and elastic fibers (see *Fig. 3*). At the bottom is a small quantity of muscle in the form of bundles scattered through connective tissue. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. A Very Superficial Part of the Human **Vaginal Mucous Membrane.** × **65.** There is seen chiefly the heavy stratified squamous epithelium, the upper layers of which by forming keratohyalin almost attain a condition of cornification. The flat cells of the most superficial layers lie parallel to the surface, while those of the deeper layers are perpendicular. Conical projections of epithelium extend deep into the tunica propria while the papillae of the latter are relatively poorly developed. **Technique** and source as for *Fig. 1.*

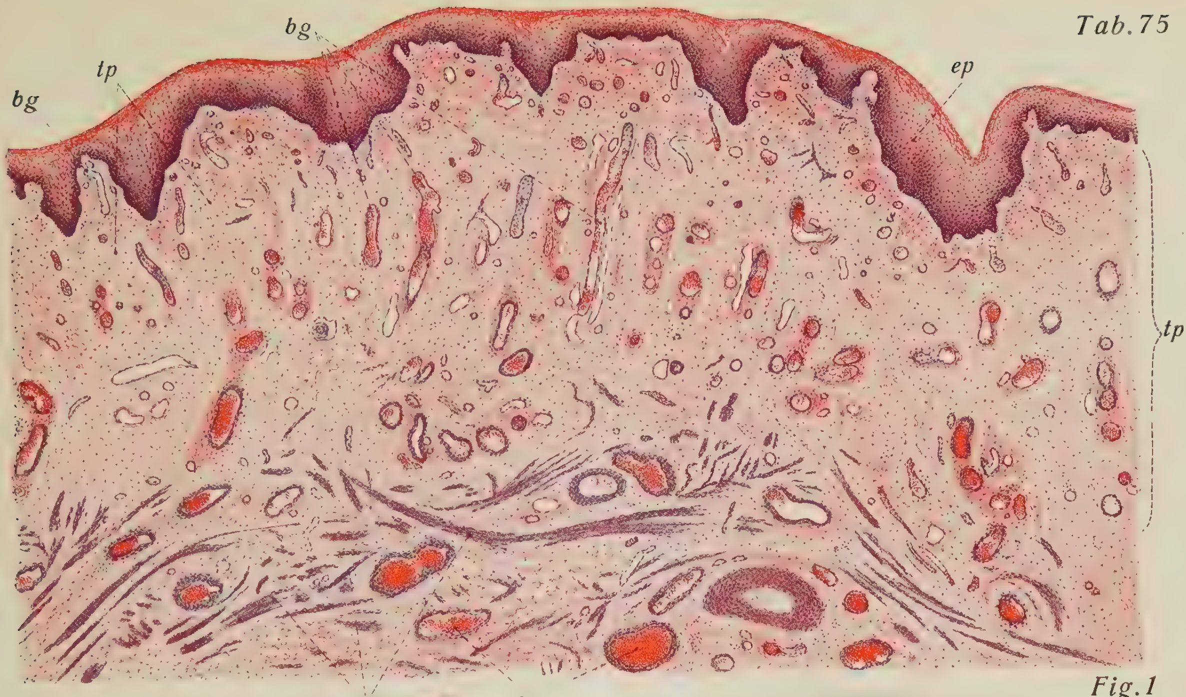
Fig. 3. **Mucous Membrane from the Human Vagina.** × **70.** Only the elastic fibers of the tunica propria are stained (brown). Note their abundance in the mucous membrane and how they extend into the papillae. The epithelium appears quite clear under this method of staining. **Technique:** Absolute alcohol. Celloidin. Orcein.

Fig. 4. A Transverse Section of a Human **Labium Minus.** × **15.** A thin layer of corium occupying the middle is covered on both sides by the modified integument. Hairs and sweat glands are entirely lacking; while sebaceous glands are all the more abundant. Several of their wide mouths are cut in the section. Note the unusually great mass of sebaceous glands which follow closely one upon another and occupy both sides of the labium. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

bd = connective tissue
bg = blood vessels
ep = epithelium
epz = epithelial cones
de = duct of sebaceous gland

glse = sebaceous glands
mfb = bundles of smooth muscle fibers
pap = papillae
tp = tunica propria

Tab. 75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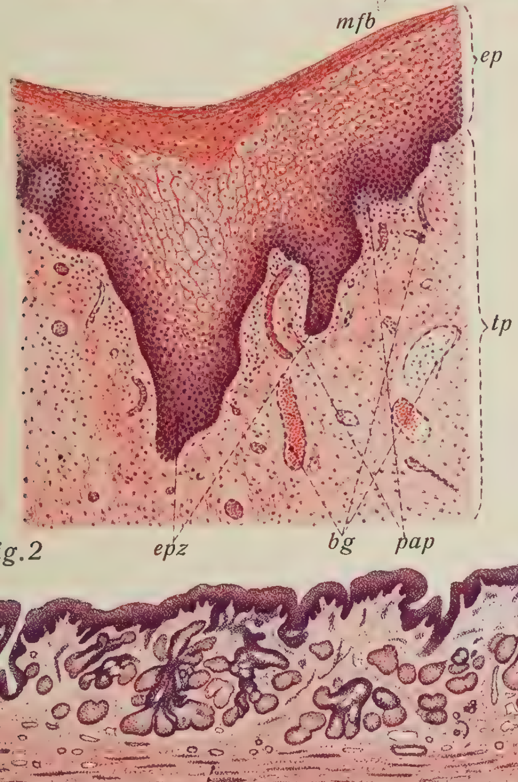
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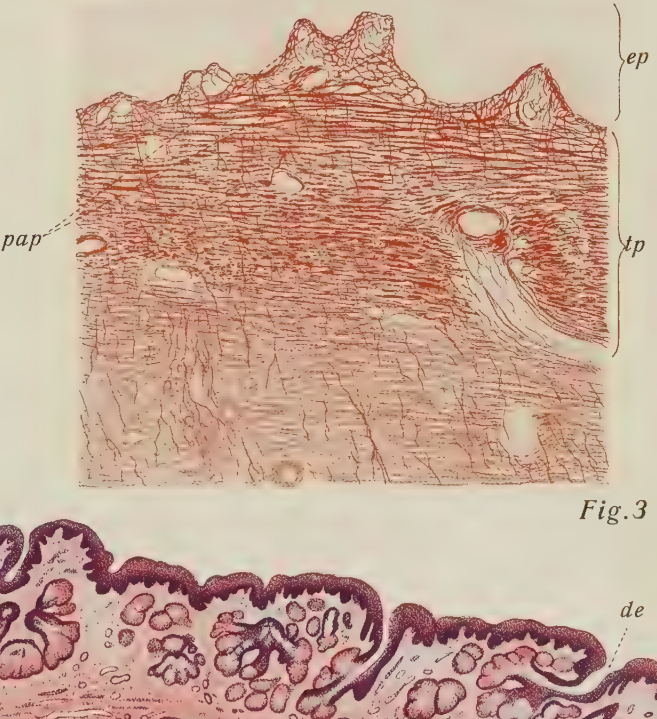

Fig. 3

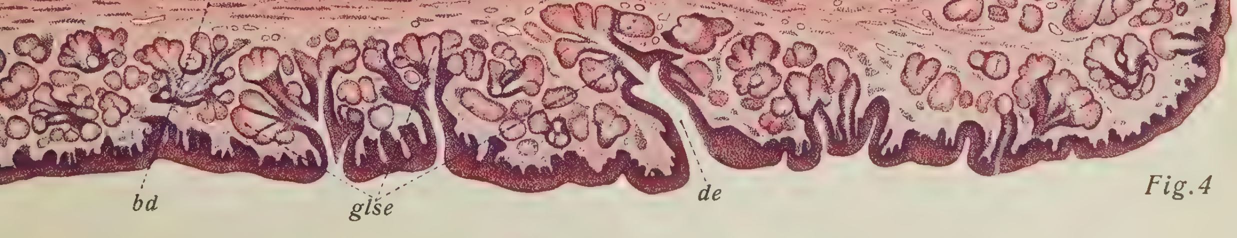
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Fig. 4

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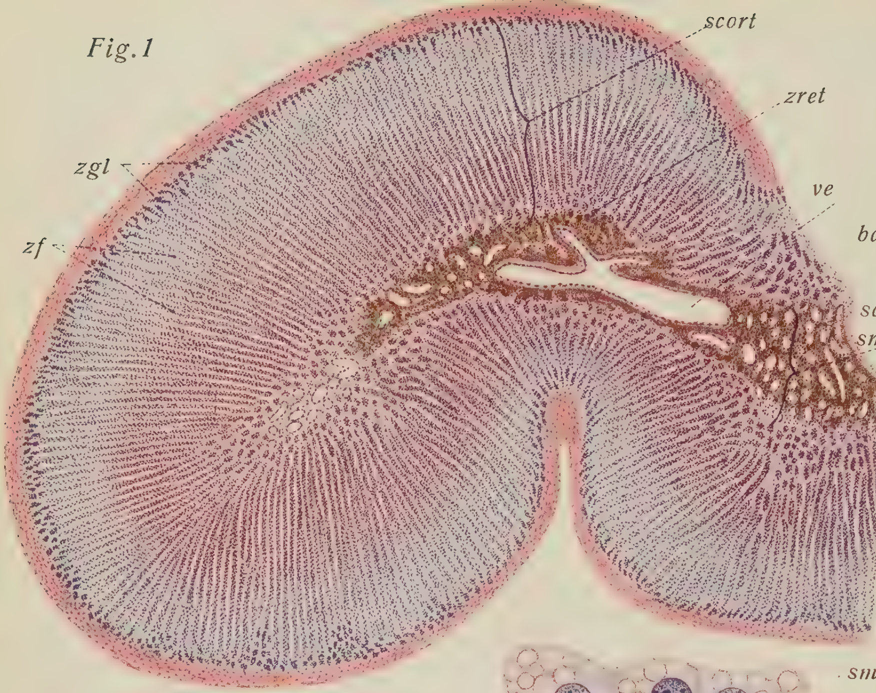
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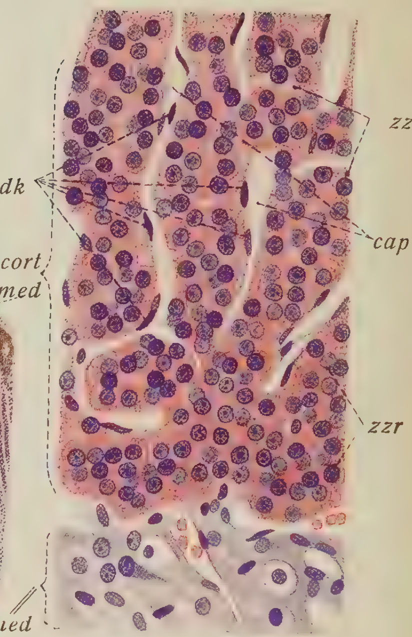
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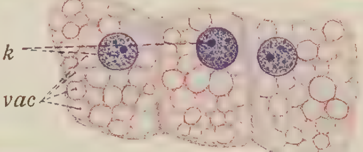

Fig. 4

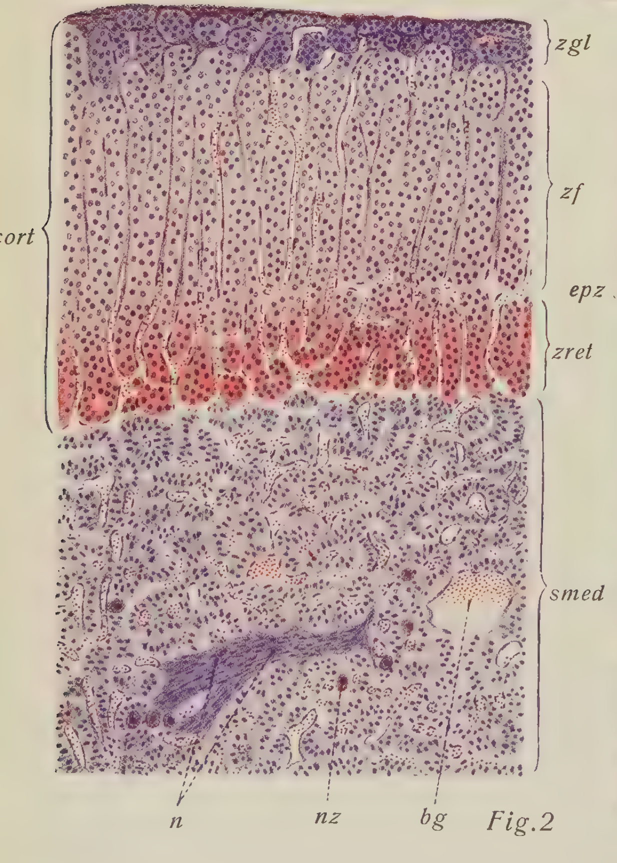
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Fig. 2

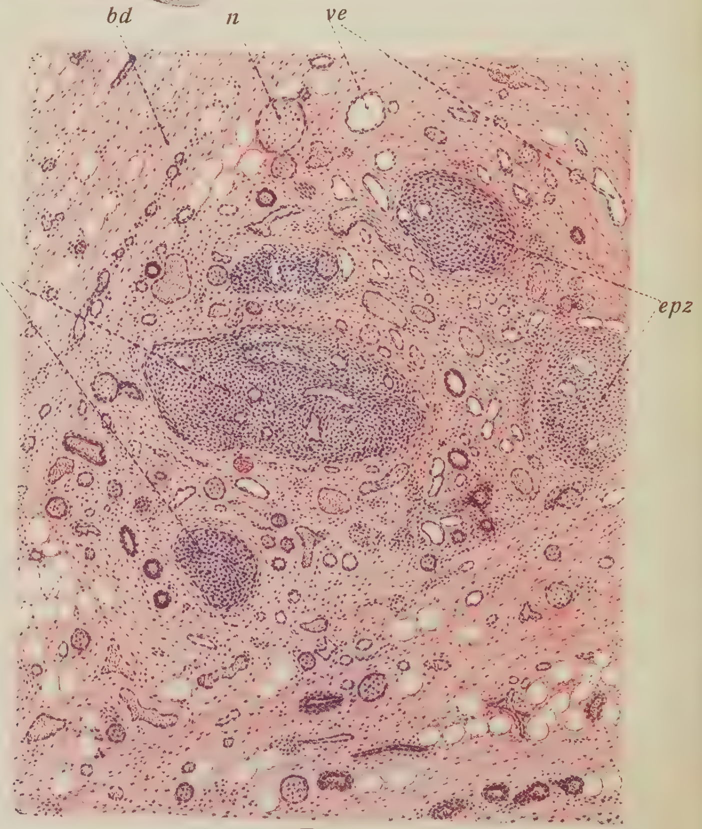
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Fig. 5

Plate 76. **Adrenal Gland, Carotid Gland.**

Fig. 1. Part of a Section from an **Adrenal Gland** (**Human,** aet. 28. Execution). × **20.** General view. On the exterior is the capsule and beneath it the broad cortex, the subdivision of which into three zones is evident. In the center is the chromaffine medulla, brown from treatment with salts of chromic acid. In the present case it is relatively little developed. Within the medulla are seen the lumina of large veins. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of a Vertical Section through an **Adrenal Gland** (Human, aet. 22. Execution). × **100.** From a gland with well developed medulla and relatively small cortex, a contrast to that of *Fig. 1.* Above is the cortex with its columns of cells and the three zones into which they are subdivided. Between the columns of cells are connective-tissue septa containing capillaries. Beneath, and sharply marked off from the cortex, is the medulla with chains of chromaffine cells and numerous blood vessels. A medullated nerve trunk and scattered sympathetic nerve cells are also to be seen. **Technique:** picro-sublimate. Paraffine. Haematoxylin-eosin.

Fig. 3. **Cortex** of the Adrenal Gland (Human, aet. 21. Execution). × **375.** The figure shows only the deeper layers of the cortex (part of the zona fasciculata and the zona reticularis), and a small part of the medulla, the cells of which however are not very characteristic. The cells of the zona reticularis contain numerous granules of brown pigment. Between the columns of cells of the zona fasciculata are septa of connective tissue containing blood capillaries. **Technique** as for *Fig. 2.*

Fig. 4. Three **Cells of the Zona Fasciculata** from the Cortex of a Human Adrenal Gland. × **900.** The fat-like substances have been dissolved out of the plasma of the cells; consequently empty vacuoles appear to fill the entire cytosome. **Technique** and source as for *Fig. 1.*

Fig. 5. A Section through the Human **Carotid Gland.** × **70.** Within a connective tissue which is extremely rich in blood vessels and small, non-medullated nerve trunks are seen a number of masses differing in size and formed of small epithelial cells. These masses stand out sharply against the connective tissue; they contain, even in their interior parts, an abundance of blood vessels (capillaries). **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

bd = connective tissue
bdk = nuclei of connective tissue
bg = blood vessel
cap = capillaries
epz = masses of epithelial cells in the glomus caroticum
k = nuclei
n = small nerve trunk
nz = nerve cell

smed = medulla
scort = cortex
vac = vacuoles
ve = veins
zf = zona fasciculata
zgl = zona glomerulosa
zret = zona reticularis
zzr = cells of the zona reticularis

Plate 77. **Eye I.**

Fig. 1. A Meridional Section through the **Eyeball** (**Human,** aet. 28. Execution). **General View of the Structure of the Eyeball.** × **7.** The section passes through the fovea centralis and the entrance of the optic nerve. The vitreous body is not represented. The figure serves for an examination of the eyeball in matters that stand midway between the macroscopic and the microscopic. The lens is in its condition of maximal curvature.[1] Note the general spatial relations of the different parts of the eyeball and the comparative thickness of its different coats. **Technique:** 2% Chromic acid. Celloidin. Van Gieson's Haematoxylin and picro-fuchsin.

Fig. 2. Part of a Meridional Section of the **Eyeball. Region of the Ciliary Body** (**Child** of 12 years). × **36.** The entire ciliary body is represented with the ciliary muscle and ciliary processes, some of which are cut through tangentially. In addition the root of the iris is shown and the angle of the anterior chamber containing the last remnants of the pectinate ligament; also the adjacent part of the sclera with the sinus venosus sclerae. Some fibers of the zonula, stained yellow, are also seen. The ciliary muscle being stained yellow stands out clearly in contrast to the red-stained connective tissue of the ciliary body and sclera. **Technique** as for *Fig. 1.*

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[1] The lens in the preparation was apparently somewhat swollen.

ar = arachnoidal portion of sheath of optic nerve
cob = conjunctiva bulbi
du = dural portion of sheath of optic nerve
fc = fovea centralis
kz = nuclear zone of lens
lc = lamina cribrosa sclerae
lp = pectinate ligament
mc = ciliary muscle
mc_1 = circular portion of ciliary muscle
mc_2 = meridional portion of ciliary muscle
pi = pigmentary epithelium
prc = ciliary processes
spi = stratum pigmenti iridis
zf = zonular fibers
+ = tangential sections of ciliary processes

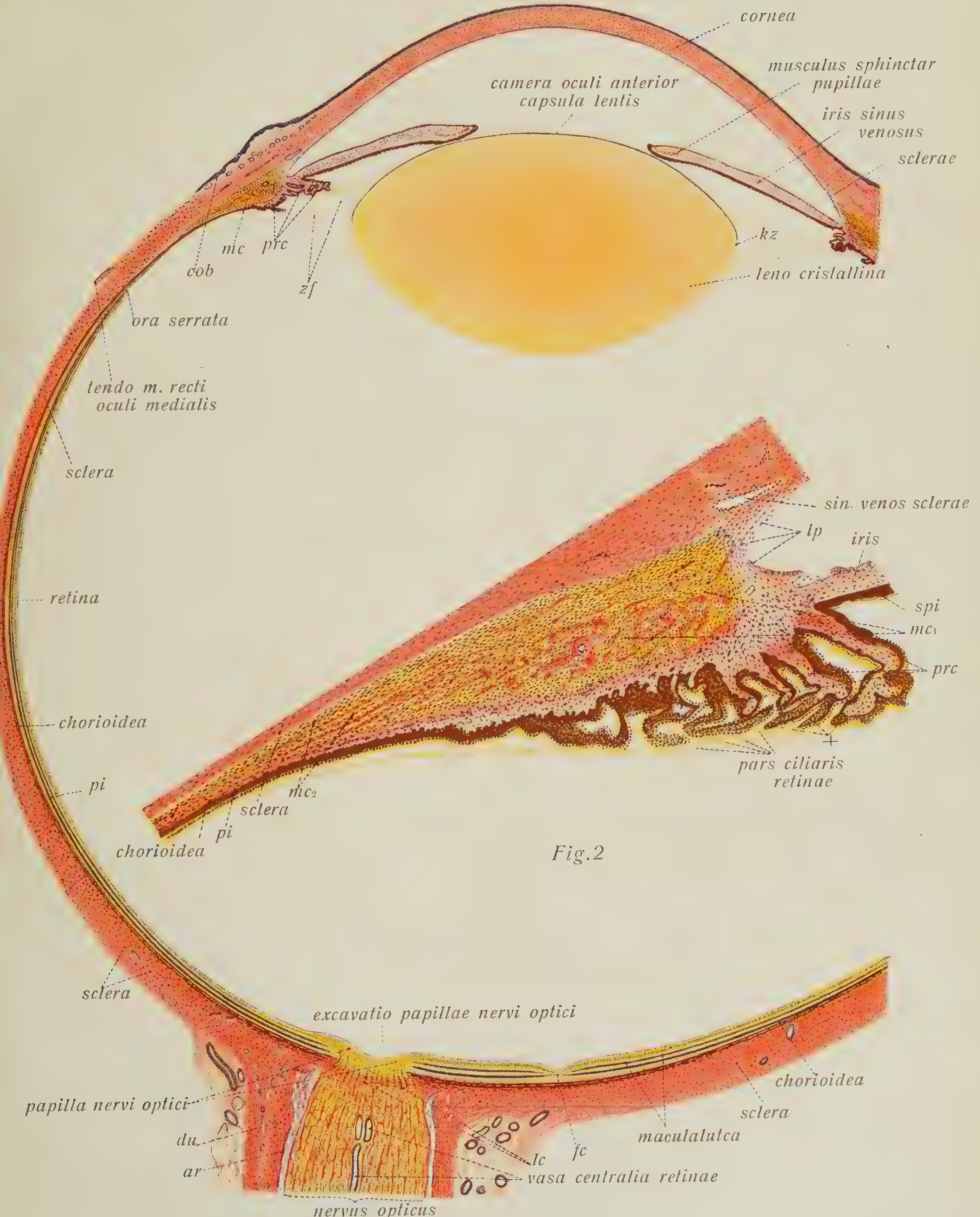
cornea
musculus sphinctar pupillae
camera oculi anterior
capsula lentis
iris sinus venosus
sclerae
kz
lens cristallina
cob
mc
prc
zf
ora serrata
tendo m. recti oculi medialis
sclera
retina
chorioidea
pi
sin. venos sclerae
lp
iris
spi
mc₁
prc
+
pars ciliaris retinae
mc₂
sclera
pi
chorioidea
sclera
excavatio papillae nervi optici
chorioidea
papilla nervi optici
sclera
du
ar
macula lutea
fc
lc
vasa centralia retinae
nervus opticus

Fig. 2

Fig. 1

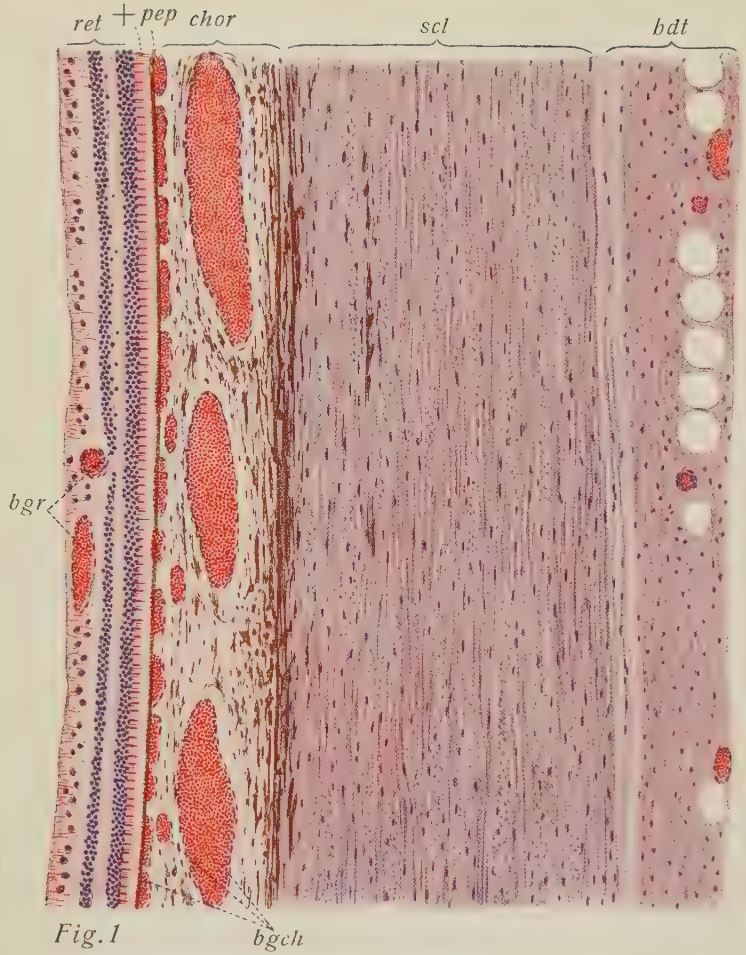
ret
+
pep
chor
scl
bdt
bgr
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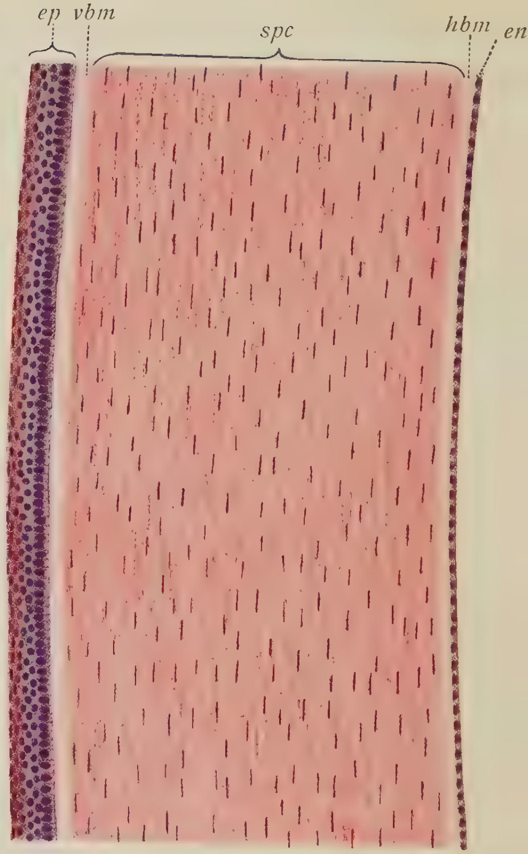
Fig. 1


ep
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spc
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Fig. 2

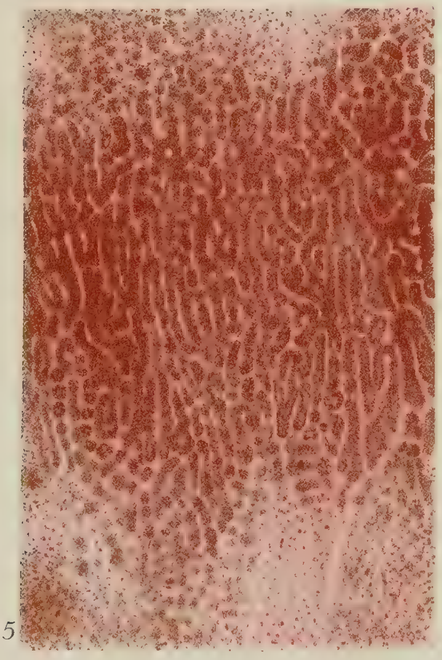

Fig. 5

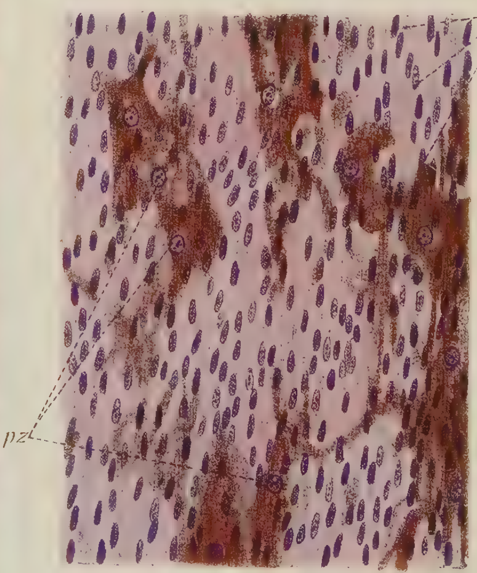

Fig. 4

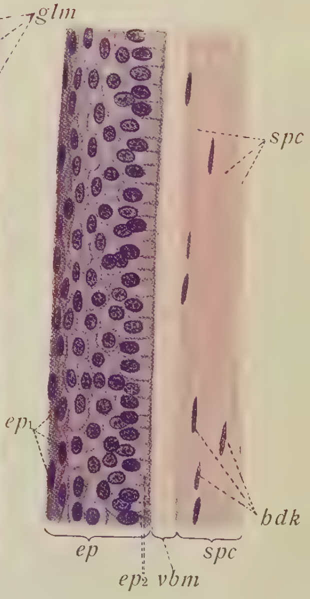
spc
ep1
bdk
ep
spc
ep2
vbm

Fig. 3

Plate 78. **Eye II (Coats of the Eyeball, Cornea).**

Fig. 1. A Section Perpendicular to the **Wall of the Eyeball** (**Human,** aet. 22. Execution). × **80.** General view of the structure of the wall of the bulbus oculi and its three coats. On the left is the retina with its nucleated layers and its blood vessels; then follows the pigmentary epithelium like a dark brown line. The middle coat is the chorioidea containing vessels well filled with blood and embedded in pigmented connective tissue. The choriocapillaris is at the left of the coat next to the pigmentary epithelium. Next toward the right is the external and strongest coat of the eyeball, the sclera, composed of dense fibrous connective tissue so arranged that layers in which the bundles are cut across alternate with others in which they are cut longitudinally. At the extreme right is the connective tissue forming the capsule of Tenon; it contains fat cells. The clear zone between the sclera and this capsule represents the loose connective tissue of the space of Tenon. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. From a Section Perpendicular to the **Cornea** (Human, aet. 28. Execution). × **80.** The five layers of the cornea may be clearly distinguished. On the left is the corneal epithelium. Beneath it is the anterior basal membrane (of Bowman), then follows the substantia propria corneae, by far the thickest layer of the cornea. It terminates at the posterior basal membrane (of Descemet), and finally at the extreme right is the flat corneal endothelium (cf. *Fig. 5*, Pl. 8). Note that the substantia propria corneae is composed of a large number of parallel lamellae of connective tissue, between which lie flattened cells only the nuclei of which are seen in the figure (cf. *Fig. 7*, Pl. 6). **Technique** as for *Fig. 1.*

Fig. 3. The **Epithelium of the Human Cornea.** × **200.** The figure shows the corneal epithelium, and beneath it the anterior basal membrane; only the most anterior lamellae of the substantia propria are shown. The corneal epithelium represents the simplest form of stratified squamous epithelium; the cells of the basal layer are columnar, those of the two most superficial layers are flat. In the figure the anterior basal membrane (of Bowman) appears quite homogeneous. **Technique** and source as for *Fig. 2.*

Fig. 4. The **Lamina Fusca** Viewed from the Surface (Human). × **240.** The sclera has been removed; in doing so the tissue of the lamina fusca was torn. A few of the stout pigment cells of this layer remain upon the underlying structure (the outer surface of the ciliary muscle). The smooth muscle fibers and their long nuclei may be recognized; the connective tissue fibers of the lamina fusca are scarcely visible under the method of staining used. **Technique:** Müller's fluid. Mechanical removal of the sclera. Haematoxylin-eosin.

Fig. 5. Surface Preparation of **Müller's Reticulum** from the Human Orbiculus Ciliaris. × **175.** There is seen the inner surface of the inner and middle coats of the eyeball from the region of the orbiculus ciliaris. The peculiar outgrowths (buds) of the epithelium of the stratum pigmenti (corporis ciliaris) do not occur evenly over the whole extent of the surface of the orbiculus ciliaris, but have a netlike distribution as is seen in the figure (also *Fig. 4*, Pl. 81). **Technique:** Müller's fluid. Surface preparation. Haematoxylin-eosin.

bdk = nuclei of connective tissue
bdt = connective tissue of the capsule of Tenon
bgch = blood vessels of the chorioidea
bgr = retinal blood vessels
chor = chorioidea
end = corneal endothelium
ep = corneal epithelium
ep_1 = flat superficial cells of the corneal epithelium
ep_2 = deep basal cells of the corneal epithelium
glm = smooth muscle fibers of the ciliary muscle
hbm = posterior basal membrane
pep = pigmentary epithelium
pz = pigment cells of the lamina fusca
ret = retina
scl = sclera
spc = substantia propria corneae
vbm = anterior basal membrane
+ = rods and cones

Plate 79. **Eye III (Chorioidea, Ciliary Body, Iris, Lens).**

Fig. 1. A Vertical Section through the **Chorioid Coat and the Pigmentary Epithelium** (Human, aet. 24. Execution). × **35.** At the bottom is seen a portion of the sclera adjacent to the chorioid coat, the layers of which are distinctly shown. The clear line between the choriocapillaris and the pigmentary epithelium is the so-called membrane of Bruch. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. **Ciliary Body, Iris, Lens, Margin of the Cornea.** Part of a Meridional Section through the Eyeball (Human, aet. 28. Execution). × **20.** The entire iris is seen along with the ciliary body and ciliary processes which in places are cut tangentially, also the posterior part of the cornea and anterior part of the sclera, as well as parts of the conjunctiva bulbi, lens, and zonular fibers. **Technique:** 2% Chromic acid. Celloidin. Haematoxylin-eosin.

Fig. 3. The Structure of the **Iris.** × **62.** Part of the section pictured in *Fig. 2.* The pupillary border of the iris and the adjacent part of the lens are to be seen. The muscle of the sphincter pupillae, the stroma of the iris, and the pigmented layers of its posterior surface stand out distinctly. The oblique bundles between the sphincter and the posterior pigmented layer are those known as the radial bundles. The small groups of pigment cells lying between them are the so-called "lump" cells. **Technique** as for *Fig. 2.*

Fig. 4. From the Region of the **Orbiculus Ciliaris** of the Human Eye. × **220.** Part of a meridional section of an eyeball. On the left is ciliary muscle, then the connective stroma of the ciliary body which shows few nuclei but contains the "buds" of Müller's reticulum (stratum pigmenti corporis ciliaris). On the right is the epithelial layer of the pars ciliaris retinae and proceeding from it are zonular fibers. **Technique** and source as for *Fig. 2.*

Fig. 5. The Margin of the Lens. × **220.** From the same preparation as are *Figs. 2—4.* The upper part of the figure is toward the anterior surface and the lower part toward the posterior surface of the lens. There is seen the homogeneous capsule, also the anterior epithelium of the lens which at the equator passes into the lens fibers and the nucleated zone of the lens. **Technique** as for *Fig. 2.*

aeql = equator of lens
aco = annulus conjunctivalis corneae
art = artery
art$_1$ = branch of the arteria ciliaris longa lying between chorioidea and sclera
bd = connective tissue stroma
cl = capsule of lens
chor = chorioidea
chorc = choriocapillaris
cor = cornea
dil = dilator membrane
epc = corneal epithelium
epcon = conjunctival epithelium
epl = epithelium of lens
epp = pigmentary epithelium
epp$_1$ = pigmentary epithelium forming Müller's reticulum
irg = vessels of the iris
iris = stroma of the iris
klf = nuclei of lens fibers
lf = lens fibers
lp = remnant of the ligamentum pectinatum
mci = ciliary muscle
mpi = margin of pupil
msph = muscul. sphincter pupillae
pcir = pars ciliaris retinae
pir = pars iridica retinae
pl = pigmentary lamellae of the posterior surface of the iris
pli = plicae iridis
procc = ciliary processes
scl = sclera
svscl = sinus venosus sclerae
sprc = substantia propria corneae
such = lamina suprachorioidea
ve = larger veins of the chorioidea
ve$_1$ = smaller veins of the chorioidea
vir = anterior limiting layer of the iris
zf = zonular fibers
* = point where the two lamellae of the optic cup become continuous
** = pigmentary lamellae of posterior surface of iris lining the pupillary canal

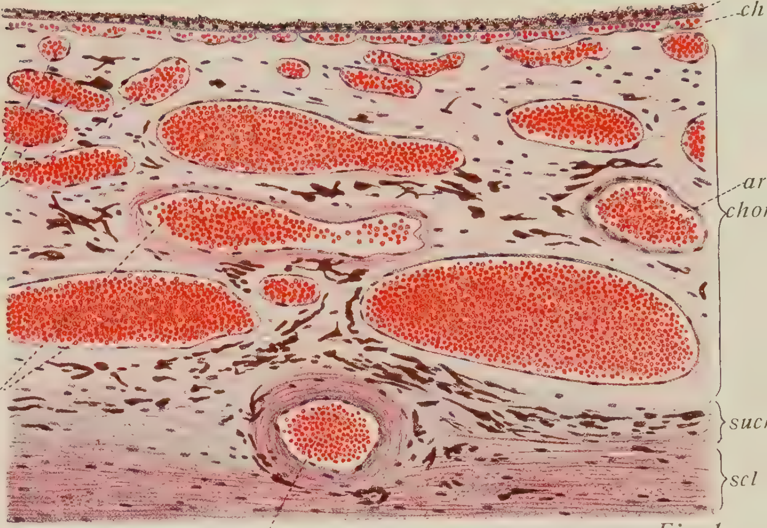
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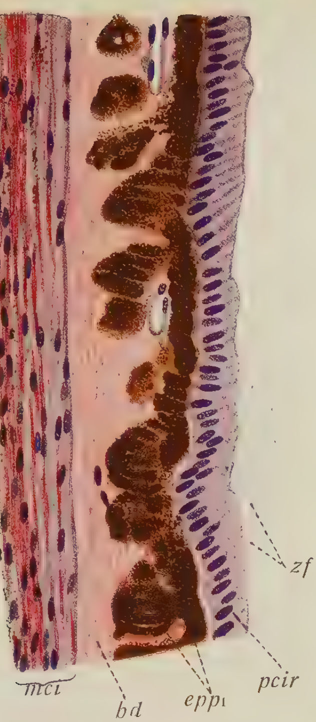
Fig. 1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pcir

Fig. 4

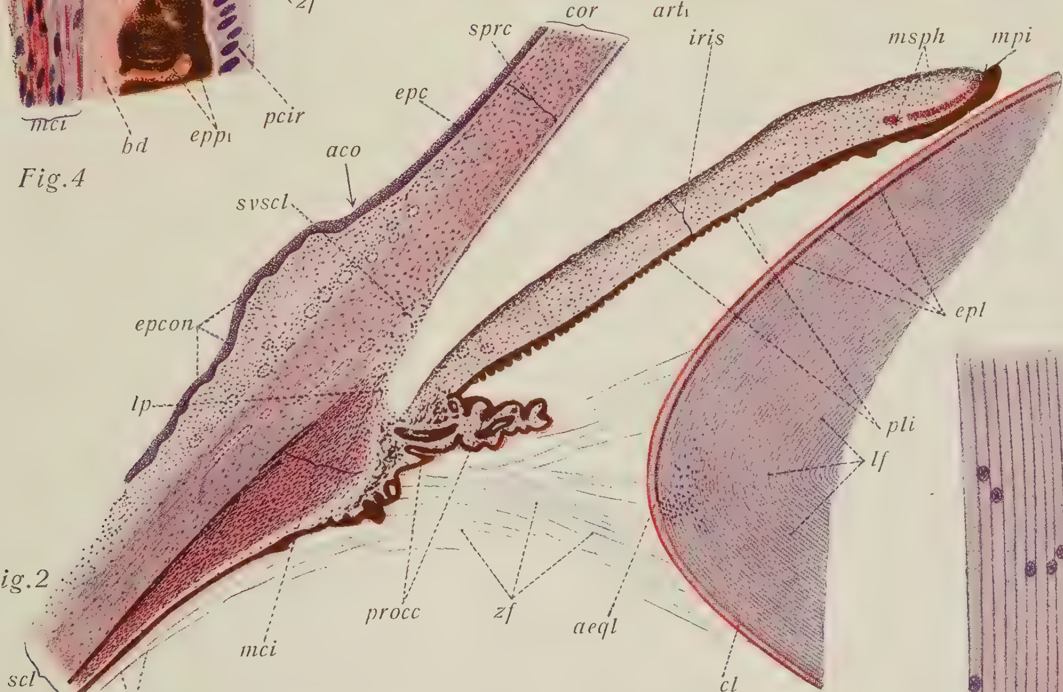
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Fig. 2

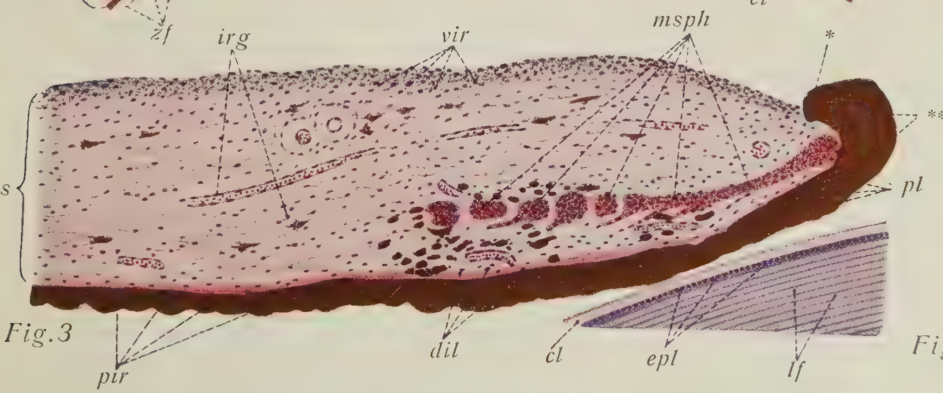
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Fig. 3

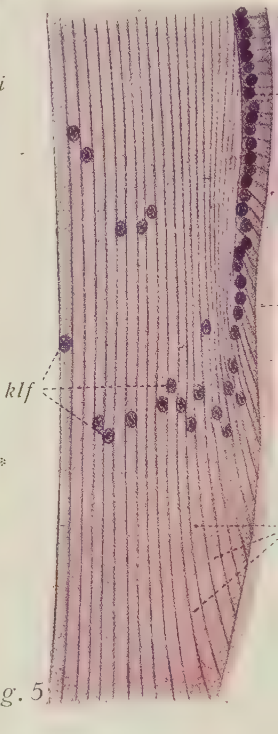

Fig. 5

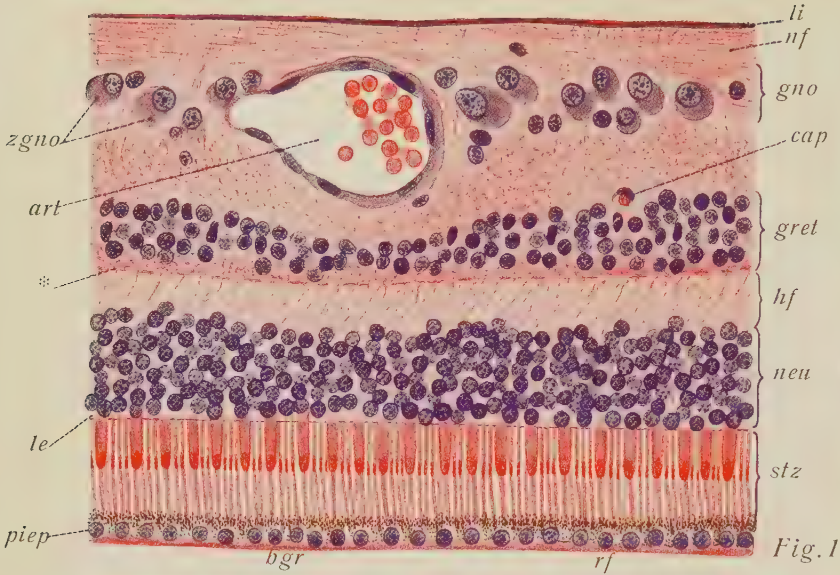
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Fig. 1

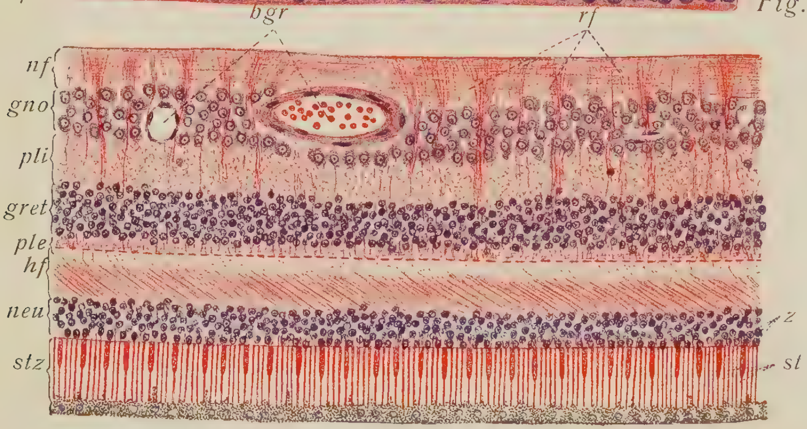
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Fig. 2

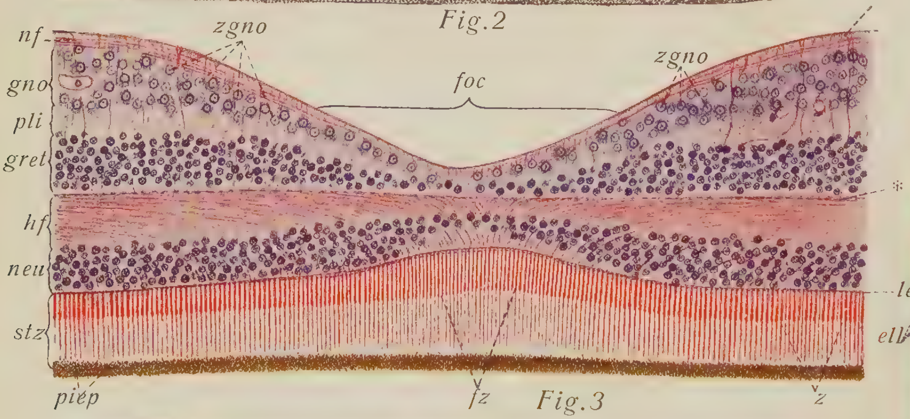
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Fig. 3

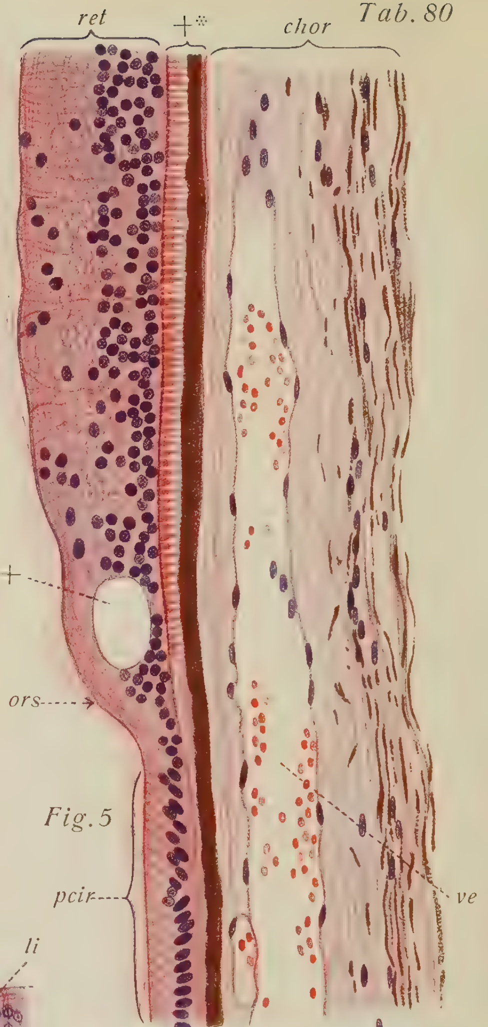
ret
+*
chor
+
ors
pcir
ve

Fig. 5

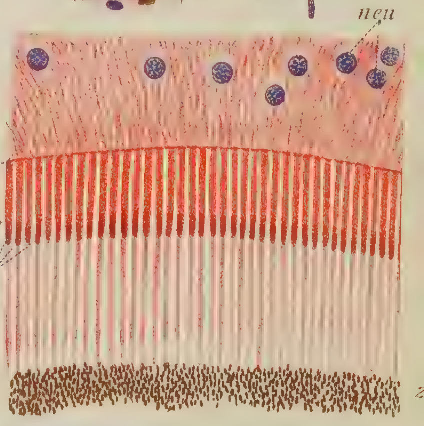

Fig. 4

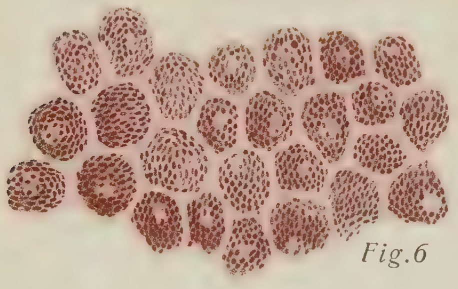

Fig. 6

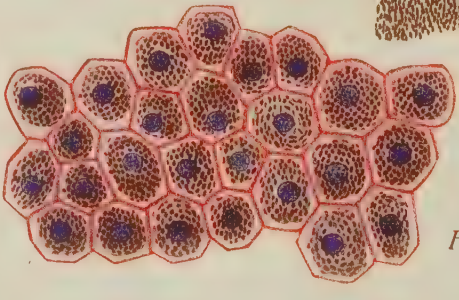

Fig. 7

Plate 80. **Eye IV (Retina, Pigmentary Epithelium).**

Fig. 1. Part of a Vertical Section through the **Retina and the Stratum Pigmenti Retinae** (Middle Region of Eyeball). × **400.** (Human, aet. 22. Execution.) General view of the structure of the retina in the region external to the macula lutea. There are seen a few cells of the ganglion nervi optici; the inner granular layer is decidedly thinner than the outer and the rods greatly outnumber the cones. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 2. Part of a Section Perpendicular to the **Retina** through the Border Zone of the Macula Lutea (Human, aet. 24. Execution). × **180.** General view of the structure of the retina: nerve fibers, ganglion cells, inner granular and Henle's fiber layers both very strongly developed, the inner granular layer being thicker than the outer. The cells of the ganglion nervi optici form several rows and there is an increase in the number of cones. The feet of the cone fibers appear as an interrupted red line at the boundary between Henle's fiber layer and the external reticular layer. **Technique** as for *Fig. 1.*

Fig. 3. A Section through the **Fovea Centralis** (Human, aet. 21. Execution). × **175.** The fovea centralis as seen is typical. At the bottom of the depression almost all the retinal layers are reduced to a minimum but the cones which produce the fovea externa are greatly increased in length — foveal cones. **Technique:** Nitric acid—potassium bichromate. Paraffine. Iron haematoxylin—Bordeaux red.

Fig. 4. **Foveal Cones** from the Human Retina. × **500.** From the bottom of the fovea centralis; detail of *Fig. 3.* Note the great length and slenderness of this type of cone which by its length produces the fovea externa. **Technique** as for *Fig. 3.*

Fig. 5. Meridional Section through the Inner and a Part of the Middle Coats of the Eyeball in the Region of the **Ora Serrata** (Human, aet. 28. Execution). × **270.** There is seen the transition from the pars optica retinae to the simple epithelium of the pars ciliaris; also the pigmentary epithelium and the adjacent layer of the chorioidea. The internal and the external granular layers have united; the layer of nerve fibers and the ganglion cell layer are almost entirely lacking. There are no rods; only stout cones which are quite short and broad. A part of the vitreous body of the region may be seen. At the ora serrata itself is a vacuole. **Technique:** 2% Chromic acid Celloidin. Haematoxylin-eosin.

Figs. 6 and 7. Surface Views of the **Pigmentary Epithelium** of the Retina (Human, aet. 28. Execution). × **500.** The flat-cubical cells are filled with fine, short rods of fuscin, which however leave free the boundaries. In *Fig. 6* the surface of the zone adjacent to the retina is shown, no nuclei are visible; while *Fig. 7* shows the less pigmented zones next to the chorioidea, in which the nuclei lie. **Technique:** Müller's fluid. Removal of the epithelial layer. Haematoxylin.

art = artery
bgr = retinal blood vessels
cap = capillaries
chor = chorioidea
ell = ellipsoids of foveal cones
foc = fovea centralis
fz = foveal cones
gno = ganglion nervi optici
gret = inner granular layer
hf = layer of Henle's fibers
le = external limiting membrane
li = internal limiting membrane
neu = neuro-epithelium
nf = layer of nerve fibers
ors = ora serrata
pcir = pars ciliaris retinae
piep = pigmentary epithelium
ple = outer plexiform layer
pli = inner plexiform layer
ret = retina
rf = radial fibers
st = rods
stz = rods and cones
ve = vein of the ciliary body
z = cones
zgno = cells of the ganglion nervi optici
+ = vacuole in the ora serrata
* = line formed by feet of cone fibers
+* = rods and cones and pigmentary epithelium

Plate 81. **Eye V.**

Fig. 1. Part of a Vertical Section through the **Retina** (Human, aet. 21. Execution). **Region of the Macula Lutea. × 1000.**

The figure shows only the more external layers of the retina *i. e.* the neuro-epithelium. At the bottom is the pigment (fuscin) of the pigmentary epithelium in the form of short rods which have remained hanging between the outer segments of the rods and cones; then follow the rods and cones themselves. In this, the macular region, there are about two rods to one cone, in all of which inner and outer segments may be clearly distinguished. The ellipsoids may also be seen, for instance in the inner segments of the cones. Because the section is very thin the limitans externa is clearly seen to be a sievelike membrane through the holes of which the cones connect with the parts of the cells containing the nuclei (cone granules). In the external granular layer the rod granules may be clearly distinguished from the cone granules. Note how the fiber layer of Henle is composed of the rod fibers and even more noticeably of the cone fibers. **Technique:** Nitric acid—potassium bichromate. Paraffine. Iron haematoxylin—Bordeaux red.

Fig. 2. Part of a Frontal Section through the **Lens of a Child. × 220.**

Note the arrangement — not always regular — of the lens fibers in radial rows, and the cross sections of the fibers which have the form of much flattened prisms. Above is the quite structureless capsule of the lens, for a distance beneath which the fibers are more flattened than elsewhere. **Technique:** Müller's fluid. Celloidin.

Fig. 3. A Meridional Section through the **Ligamentum Pectinatum and Angle of the Anterior Chamber of the Eye of a Child.**

Above is a part of the sclera with the canal of Schlemm; beneath is the iris with its heavily pigmented posterior layer. At the right is the ciliary body with the ciliary muscle and ciliary processes. In the angle of the chamber of the eye of a child there are still present the anastomosing connective-tissue trabeculae of the ligamentum pectinatum. Note the abundance of pigment in the iris and ciliary processes. Covering the latter is the dark pigmentary epithelium and the unpigmented pars ciliaris retinae. **Technique** as for *Fig. 2.* Haematoxylin-eosin.

Fig. 4. The Human **Pars Ciliaris Retinae and Stratum Pigmenti Corporis Ciliaris** from the Region of the Orbiculus Ciliaris. **× 300.**

The section has been depigmented (cf. *Fig. 4*, Pl. 79). Above is the epithelium of the pars ciliaris retinae the cells of which are extremely long with nuclei near their bases. The fibers of the zonula ciliaris which spring from the surface of the epithelium are not represented. Beneath this layer of epithelium is the epithelium of the stratum pigmenti retinae arranged in folds which form the so-called Müller's reticulum; the cells appear quite clear and empty because the pigment has been removed. The smooth muscle at the bottom is part of the ciliary muscle; between it and the epithelium is a small amount of connective tissue which contains very few cells. In one furrow between epithelial folds there are two nuclei. **Technique:** Müller's fluid. Depigmentation by hypochlorite. Sodium carbonate. Celloidin. Haematoxylin.

Fig. 5. Posterior Layers of the Human **Iris. Epithelium of the Iris. Dilator Membrane. × 250.**

The preparation has been depigmented. Above is the connective tissue of the stroma of the iris. Below it is the striated dilator membrane and the parts of the stratum pigmenti iridis which contain the nuclei. The latter are plainly visible now that the pigment has been removed. At the bottom is the epithelium of the pars iridica retinae with its folds. The high columnar cells with relatively small nuclei near their bases appear quite empty after the removal of the granules of pigment (fuscin). **Technique** as for *Fig. 4.*

Fig. 6. The **Tissue of the Human Vitreous Body. × 800.**

The figure shows the extremely fine fibers of the vitreous body, some of which are cut longitudinally and others transversely. They form a fine gliar network in the meshes of which there lies a clear fluid. **Technique:** 1% Chromic acid. Celloidin. Iron haematoxylin.

bgi = connective-tissue stroma of iris
cal = capsule of lens
coci = ciliary body
dil = dilator membrane
epf = epithelial fold
hf = layer of Henle's fibers
ir = iris
kpe = nucleated parts of the cells of the stratum pigmenti iridis
lip = pectinate ligament
mle = external limiting membrane
pi = grains of pigment in the pigmentary epithelium of the retina
pirr = pars iridica retinae
procc = ciliary process
scl = sclera
sta = outer segments of rods
ste = ellipsoids of rods
stf = rod fibers
sti = inner segments of rods
stk = nuclei of rods
svscl = sinus venosus sclerae (canal of Schlemm)
za = outer segments of cones
ze = ellipsoids of cones
zf = cone fibers
zi = inner segments of cones
zk = nuclei of cones

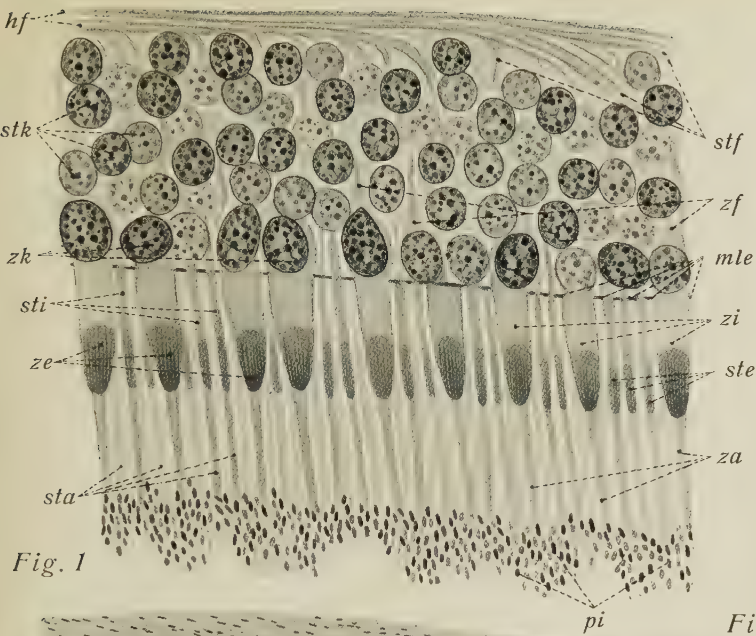
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Fig. 1

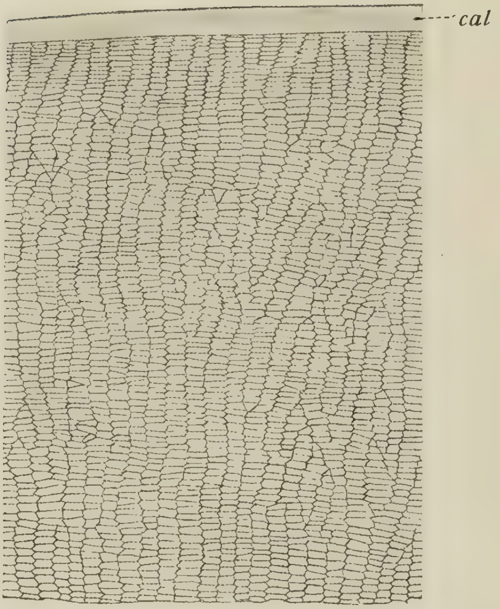

Fig. 2

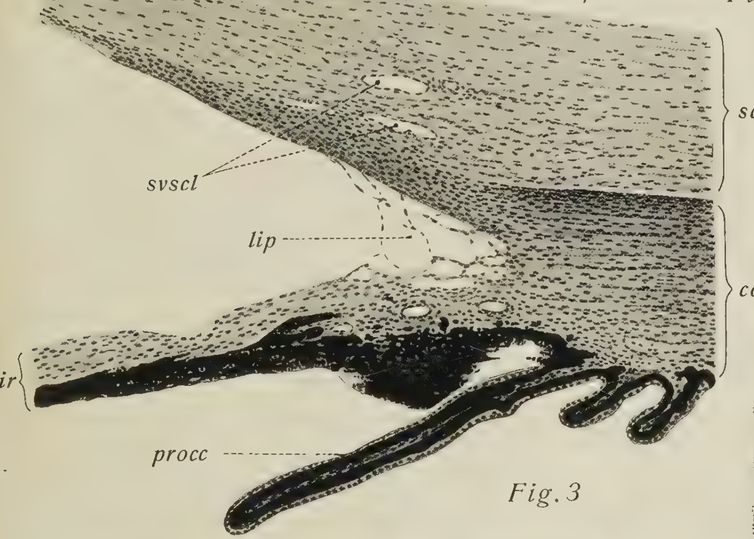
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Fig. 3

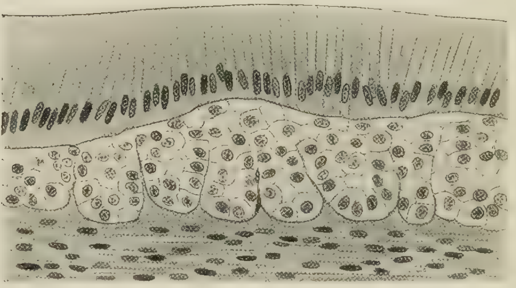

Fig. 4

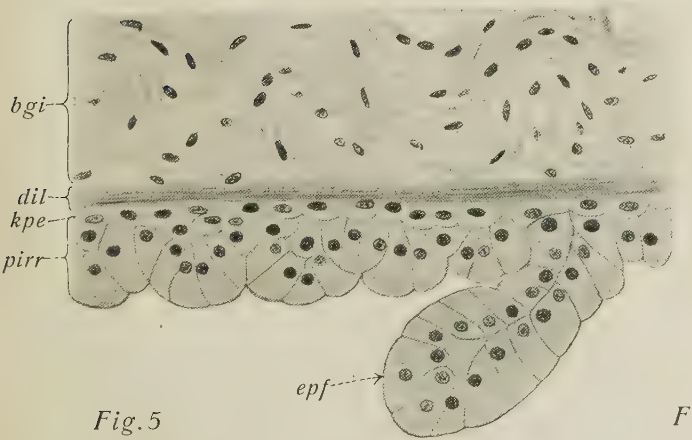
bgi
dil
kpe
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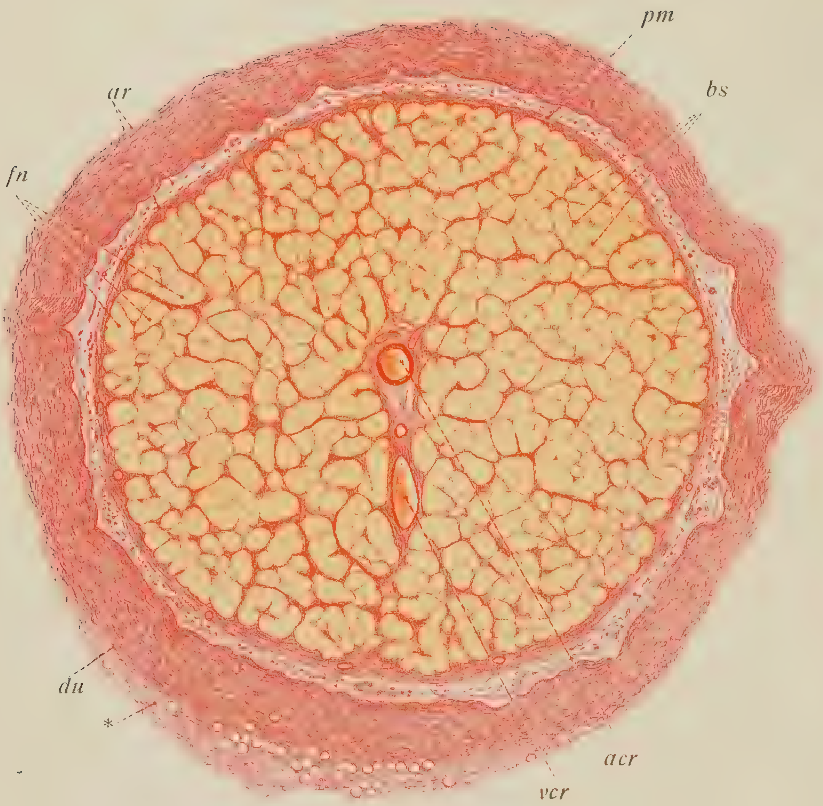
Fig. 5

Fig. 6


pm
ar
bs
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*
acr
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Fig. 1

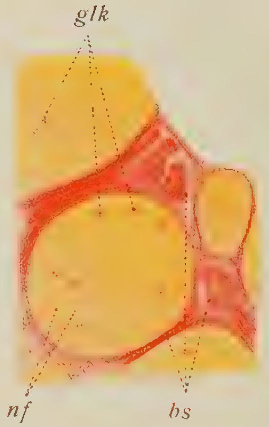


Fig. 2

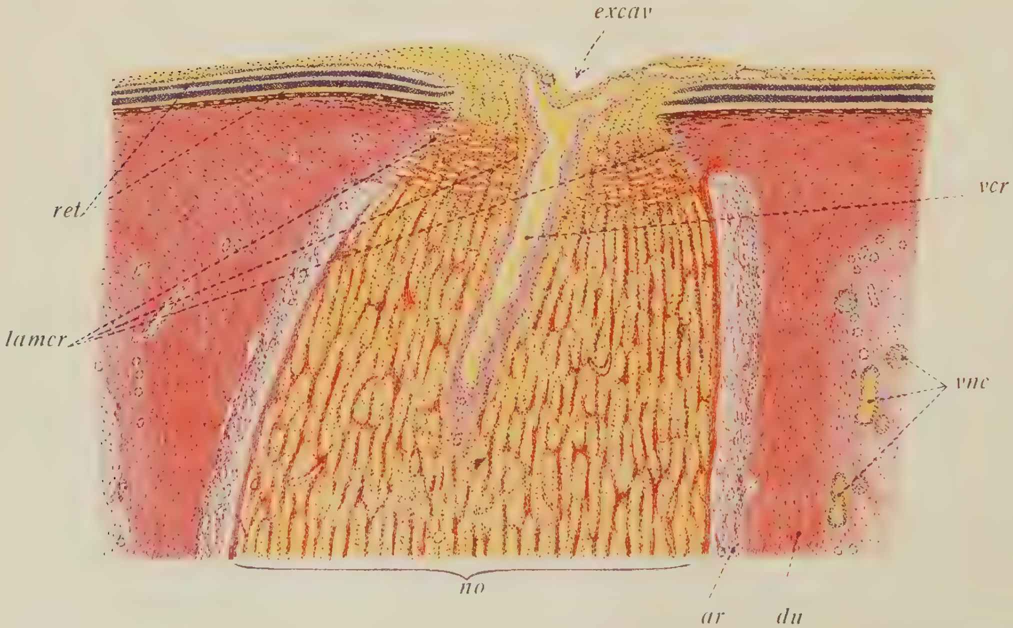

excav
ret.
vcr
lamcr.
vnc
no
ar
du

Fig. 3

Plate 82. **Optic Nerve.**

Fig. 1. Transverse Section of an **Optic Nerve** (Human, aet. 21. Execution). × **22.** The section includes the sheaths of the optic nerve as well as the nerve itself; dural, arachnoidal, and pial sheaths are clearly distinguished. Processes of pia mater, like branching septa, enter the nerve and ensheath the individual fiber bundles. Under this method of staining the distinction between neuroglia and the connective tissue of the pia mater is not evident. Note the numerous small bundles of fibers which compose the nerve; their demarcation from one another is often incomplete, a point of contrast with peripheral nerves. **Technique:** Müller's fluid. Picro-fuchsin.

Fig. 2. A Small Portion of the Section of Human **Optic Nerve** Pictured in *Fig. 1.* × **200.** A larger and a smaller bundle of nerve fibers are seen and parts of other bundles. All bundles show numerous cross sections of very fine nerve fibers (yellow), nearly all of which have the same diameter. Between the nerve fibers lie nuclei of neuroglia (pale red). The septa consist partly of connective tissue, partly of neuroglia; the two are not to be clearly distinguished under the method employed. **Technique** as for *Fig. 1.*

Fig. 3. **Longitudinal Section through the Entrance of the Optic Nerve into the Eyeball** (Human, aet. 28. Execution). × **20.** The optic nerve and its surrounding sheaths are cut longitudinally for some distance. The nerve may be traced with relatively large diameter as far as the lamina cribrosa sclerae, at this point the nerve fibers loose their medullary sheaths, the diameter of the nerve consequently diminishes, and the fibers now without medulla continue through the optic papilla into the retina. The vena centralis retinae in the nerve trunk is cut longitudinally for some distance; in the optic papilla it is seen to be formed from two roots. The passage of the bundles constituting the optic nerve through the lamina cribrosa is clearly shown; the connective tissue of the sclera like all the connective tissue in the preparation is an intense red. The physiological excavation is seen in the optic papilla. Note how the optic nerve is formed from the nerve-fiber layer of the retina, and how cleanly it passes through the pigmentary epithelium and the chorioidea; while the sclera is continuous with the dural sheath of the nerve. **Technique:** Sublimate. Celloidin. Haematoxylin—picric acid—acid fuchsin.

acr = arteria centralis retinae
ar = arachnoidea
bs = connective-tissue septa
du = dural sheath
excav = physiological excavation of the optic papilla
fn = bundles of fibers of the optic nerve
glk = nuclei of neuroglia
lamcr = lamina cribrosa sclerae
nf = nerve fibers
no = optic nerve
pm = pia mater of the optic nerve
ret = retina
vcr = vena centralis retinae
vnc = ciliary veins and nerves
* = loose connective tissue external to the dural sheath of the optic nerve

Plate 83. **Eyelid, Lachrymal Gland**

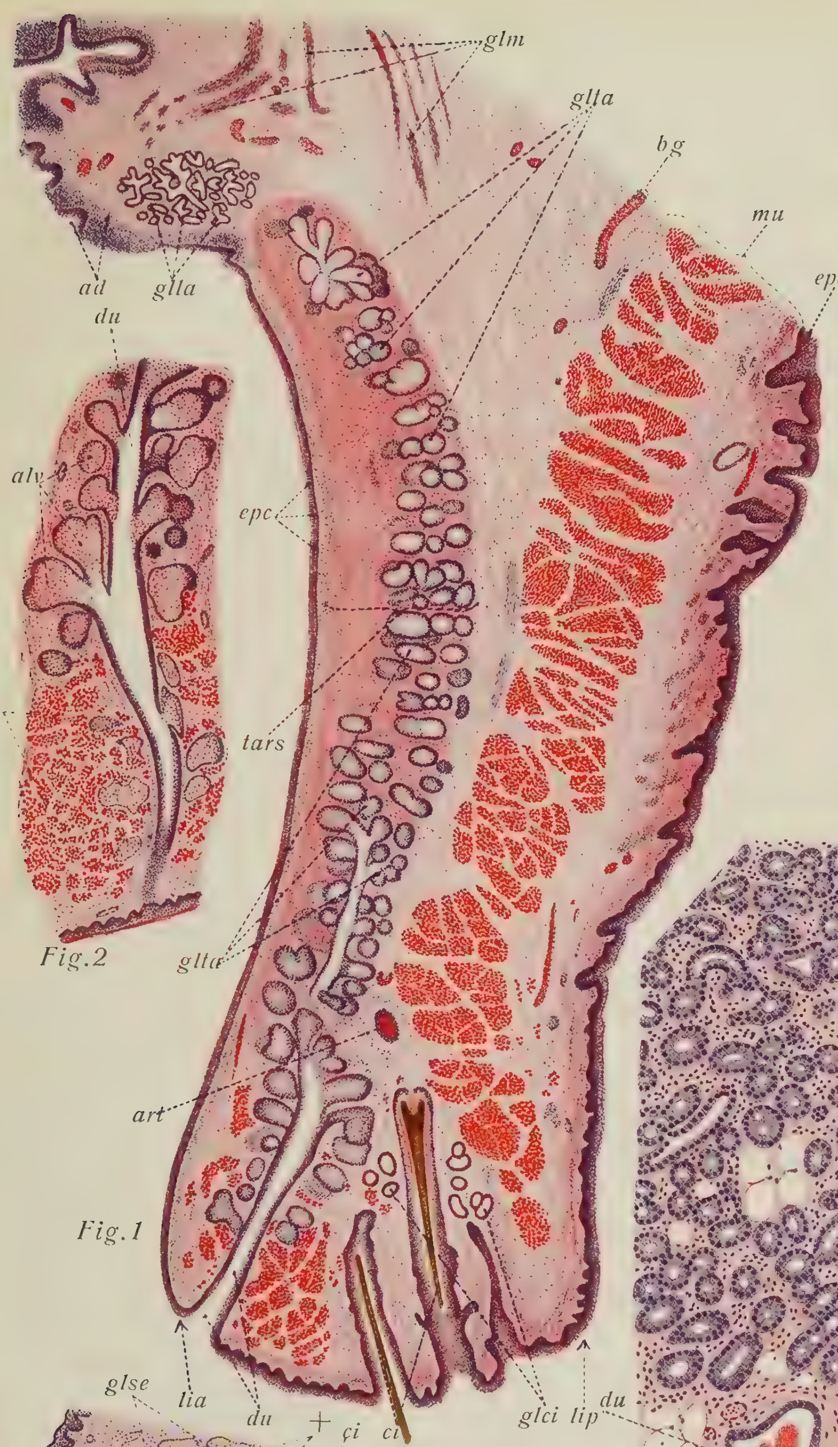
Fig. 1. Sagittal Section through **Upper Eyelid (Human,** aet. 28. Execution). × **17.** General view of the structure of the eyelid. The cutaneous surface is on the right, while on the left the conjunctival surface is seen as far as the fornix conjunctivae. Above the tarsus is an accessory lachrymal gland. The tendon of the musculus levator palpebrae superioris with its smooth muscle is also seen at the upper border of the tarsus and on its anterior surface between the tarsus and the muscle of the eyelid. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Figs. 2 and 3. Detail of the **Human Eyelid.** × **25.** *Fig. 2* shows a Meibomian gland and the portion of the tarsus next to the edge of the lid. Note the central excretory duct of the gland with the alveoli surrounding it, also the situation of the duct among the striated fibers of the so-called tarsal muscle (m. ciliaris Riolani). *Fig. 3* shows the eyelashes and their surroundings. Both of the eyelashes in the section are nearly ready to fall (clubbed hairs). With the eyelashes are the sebaceous glands belonging to them (glands of Zeiss), and the coiled glands of Moll with their ducts. **Technique** as for *Fig. 1.*

Fig. 4. A Section from the Superior Portion of the **Lachrymal Gland (Human,** aet. 28. Execution). × **150.** General view. The lobules of the gland are not compactly arranged. Stout strands of mingled adipose and connective tissue divide them from one another; even the individual tubules are separated by interstitial connective tissue rich in cells. Two excretory ducts are to be seen in the figure. **Technique:** Sublimate. Paraffine. Stain as in *Figs. 1—3.*

Fig. 5. Detail of the **Structure of the Human Lachrymal Gland.** × **375.** Here also is seen the relatively strongly developed interstitial connective tissue, rich in cells, which lies between the terminal tubuli. The latter recall in their structure that of the serous salivary glands, but their lumina are much wider. Frequently granules are observed in the general secretion zones of the cells. **Technique** as for *Fig. 4.*

ad = adenoid tissue of the conjunctiva
art = cross section of the arterial anastomosis of the inferior tarsal arch
alv = alveoli of the Meibomian gland
bdk = nuclei of connective tissue
bg = blood vessel
ci = eyelashes
ci_1 = early stage of shedding eyelash
du = excretory duct of Meibomian gland
du_1 = excretory duct of gland of Moll
epc = conjunctival epithelium
fe = adipose tissue
glci = ciliary gland (of Moll)
glla = accessory lachrymal gland
glm = smooth muscle in the tendon of the levator palpebrae
glse = sebaceous glands of the eyelashes (glands of Zeiss)
glta = tarsal glands
lia = posterior edge of lid
lip = anterior edge of lid
mc = fibers of the tarsal muscle (m. ciliaris Riolani)
mu = palpebral muscle
tars = tarsus
tub = tubuli of the lachrymal gland
+ = isolated bundles of the m. tarsalis


glm
glta
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mu
epc
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tars
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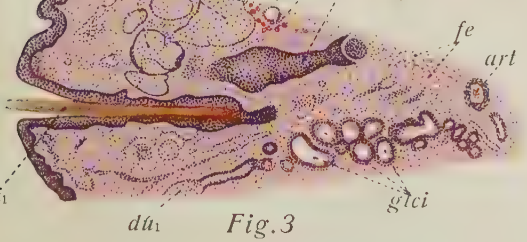
ci
glci
lip

Fig. 1

du
alv
mc

Fig. 2


glse
+
ci
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art
ci₁
du₁
glci

Fig. 3

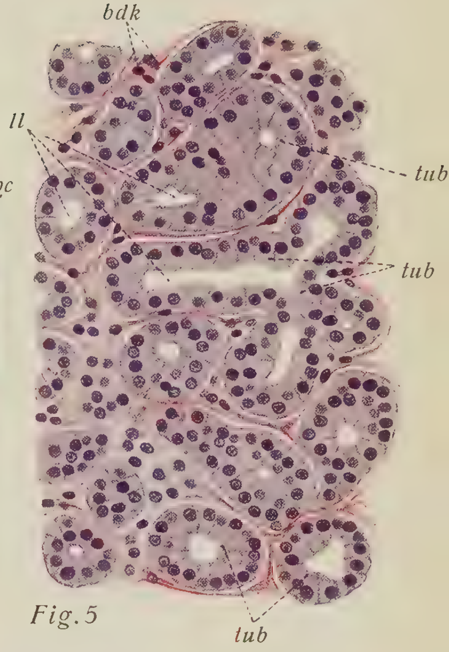
bdk
ll
tub
tub
tub

Fig. 5

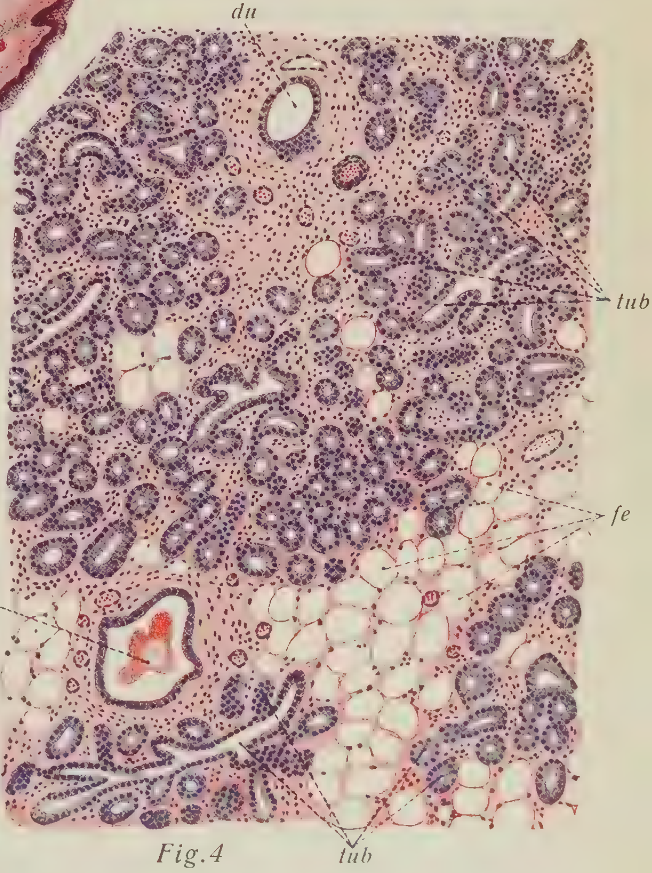
du
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Fig. 4

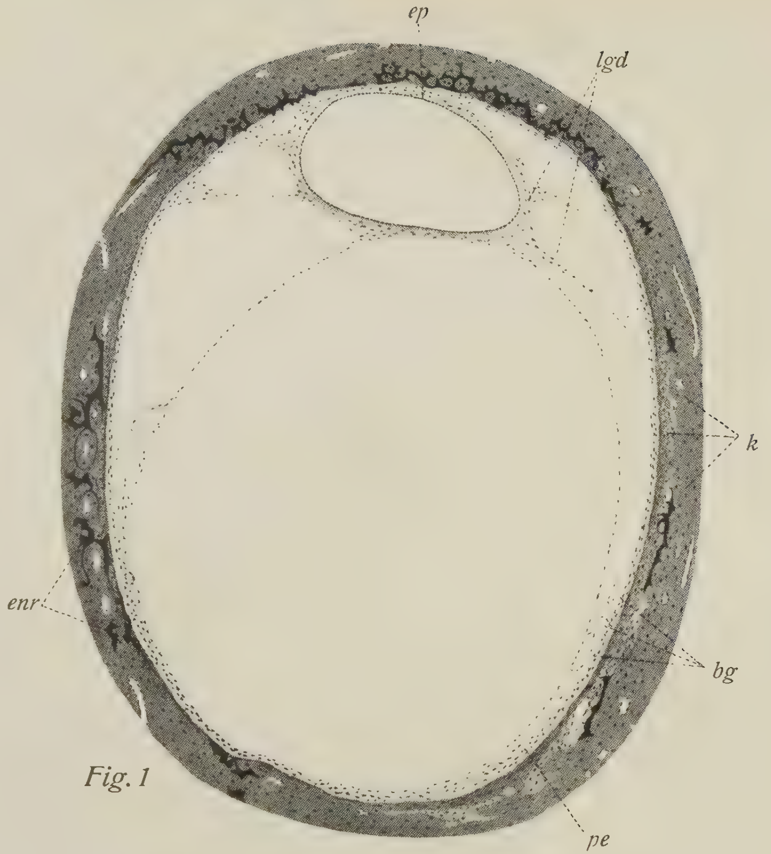
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Fig. 1

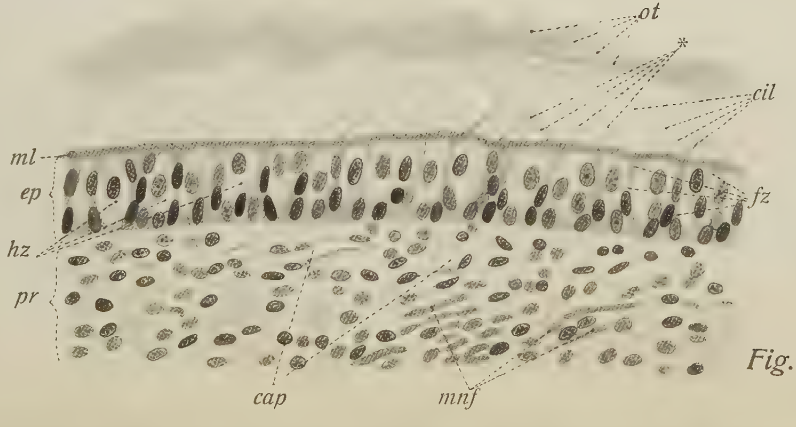
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Fig. 2

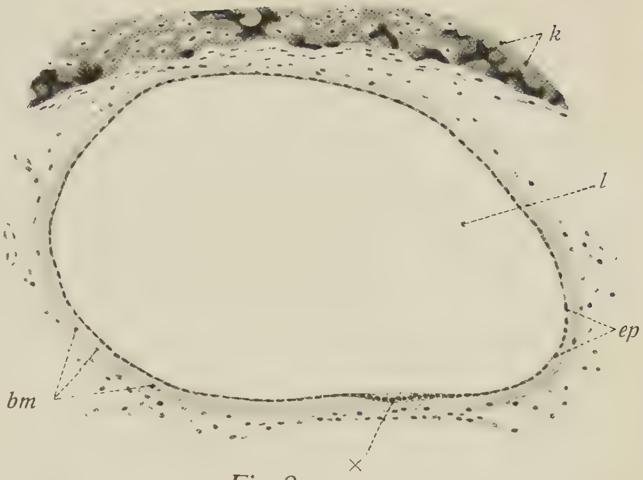


Fig. 3

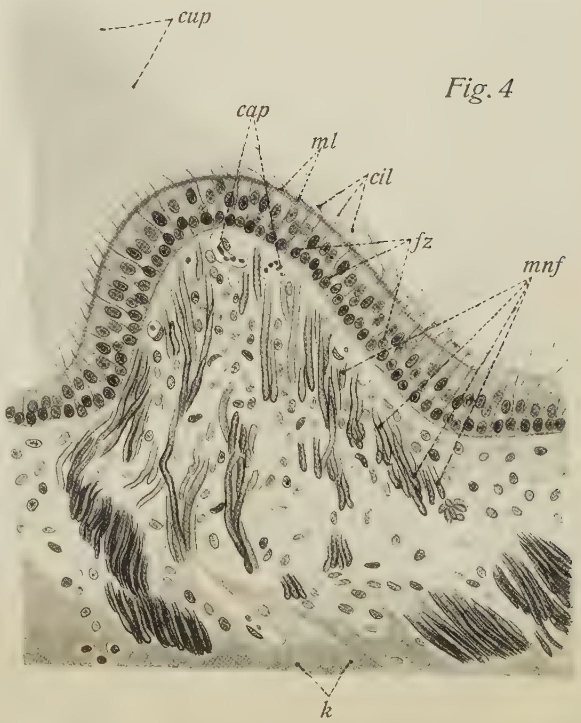

cup
cap
ml
cil
fz
mnf
k

Fig. 4

Plate 84. **Internal Ear I (Semicircular Canals, Maculae and Cristae).**

Fig. 1. Transverse Section of the **Ductus and Canalis Semicircularis** of a Newborn Child. × **55.** Above is seen the semicircular duct lying eccentrically in the bony canal. The extremely thin wall of the duct is fastened to the periosteum of the inner surface of the canal by a few strands of connective tissue which cross the perilymphatic space. Note how much the caliber of the bony canal exceeds that of the membraneous duct. The latter contains endolymph. **Technique:** Müller's fluid. Decalcification by hydrochloric acid. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of a Section Perpendicular to the **Macula Acustica** (**Human,** aet. 28. Execution). × **345.** The nature of the neuro-epithelium with its hair cells and fiber cells is clearly shown, as is also a remnant of the otolithic membrane upon the cilia of the macula. The nerve fibers are indistinct. **Technique** as for *Fig. 1.*

Fig. 3. Part of the Preparation Pictured in *Fig. 1.* × **130.** There is seen the **membraneous semicircular duct** and a small part of the adjacent bony wall and its periosteum. An unusually flat epithelium lines the endolymphatic space; it rests upon a layer of connective tissue which is also very thin. **Technique** as for *Fig. 1.*

Fig. 4. From a Section Perpendicular to the **Crista Acustica of a Cat.** × **240.** The neuro-epithelium is clearly seen with its long sensory hairs forming the conical cupula. Beneath the crista the superficial layer of the bone is represented. The medullated nerve fibers stand out clearly, their medullary sheaths having been blackened by the action of the osmic acid. **Technique:** Platinum chloride—osmo—acetic acid. Treatment with red pyroligneous acid. Decalcification by picric acid. Celloidin. No further staining.

bg = blood vessels
bm = basal membrane + tunica propria
cap = capillaries
cil = sensory hairs
cup = cupula
enr = remains of calcified cartilage matrix
ep = epithelium
fz = fiber cells
hz = hair cells
k = bone
l = lumen
ldg = ligamenta ductus
ml = limiting membrane
mnf = medullated nerve fibers
ot = otolithic membrane
pe = periosteum
pr = tunica propria
× = so-called „seam" of the epithelium of the semicircular canal
* = droplets of mucus (?)

Plate 85. **Inner Ear II (Cochlea).**

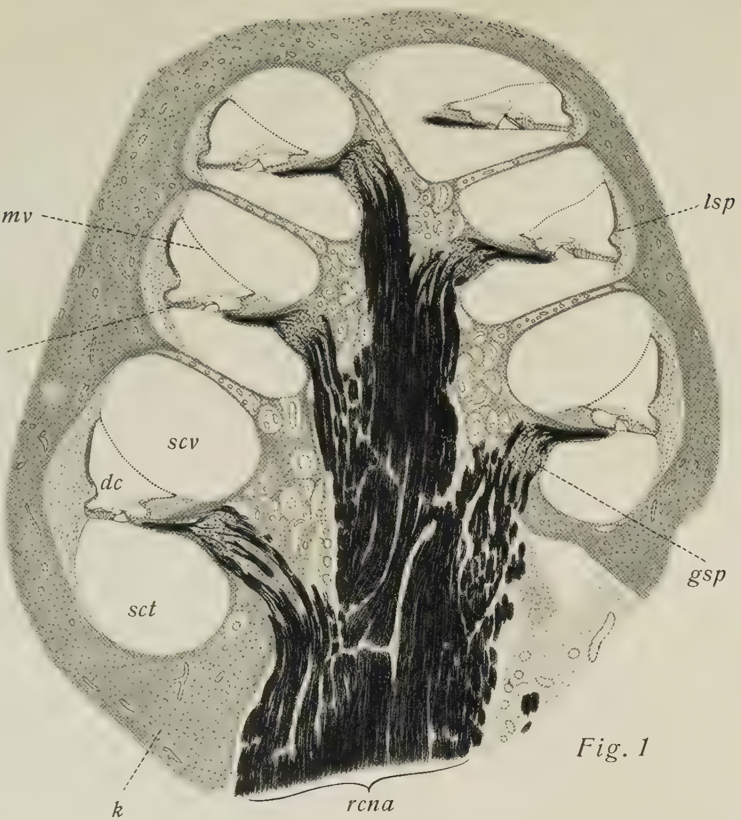
Fig. 1. Axial Section of the **Cochlea** (Cat). × **25.** General view. The cupula is above and the basis cochleae is below. In the modiolus the masses of nerve fibers of the cochlear branch of the acustic nerve have been blackened by osmium. Laterally branches of the nerve may be traced in the membrana spiralis ossea to the spiral ganglion, from which indeed the nerve fibers arise. The osseous cochlear duct is cut six times. Its subdivision into scala tympani, ductus cochlearis, and scale vestibuli may be recognized. At the apex of the cochlea is seen the helicotrema, affording communication between the two perilymphatic spaces (scalae). **Technique:** Platinum chloride—osmo—acetic acid. Washing out in methyl alcohol. Treatment with red pyroligneous acid. Mounting in Canada balsam without further staining.

Fig. 2. **Cochlear Duct.** × **80.** The middle turn of the left side of *Fig. 1.* General view, especially of the cochlear duct and organ of Corti. In the middle is the endolymphatic ductus cochlearis separated from the perilymphatic scala vestibuli by the thin membrana vestibularis. The spiral ganglion is seen at the base of the osseous spiral lamina and the organ of Corti rests upon the lamina membranacea; while beneath the spiral membrane is the perilymphatic scala tympani. **Technique** as for *Fig. 1.*

Fig. 3. The **Organ of Corti.** × **300.** Detail of *Fig. 2* from the same preparation. Hair cells. Rods and tunnel of Corti. Membrana tectoria. The supporting substance in the rods of Corti is stained very dark. **Technique** as for *Fig. 1.*

Fig. 4. **Surface View** of a Portion of the **Organ of Corti** from the Middle Turn of a Human Cochlea (somewhat diagrammatic). × **400.** The figure is so oriented as to be the direct complement of *Fig. 3*, the epithelium being seen from above; detail is shown as deep as the level of the nuclei of the hair cells. The shafts of the rods are represented as showing through from a still deeper position. Viewed thus the difference in length between inner and outer rods is very noticeable. **Technique** as for *Fig. 1.*

ahz = outer hair cells
anz (Fig. 4) = outer hair cells
apf = outer rods
apf$_1$ = outer rods (seen through the epithelium) and their phalangeal processes
bg = blood vessels
clz = cells of Claudius
dc = ductus cochlearis
dz = outer cells of Deiters
epsp = epithelium of the sulcus spiralis
gsp = spiral ganglion
hez = Hensen's cells
ihz = inner hair cells
ipf = inner rods
ipf$_1$ = inner rods (seen through the epithelium), their phalangeal processes, and the inner cells of Deiters
k = bone
kapf = heads of outer rods
kipf = heads of inner rods
kpipf = head plates of inner rods
lisp = limbus spiralis
lsp = spiral ligament
lspm = lamina spiralis membranacea
lspo = lamina spiralis ossea
lty = labium tympanicum
lv = labium vestibulare
mb = membrana basilaris
mv = membrana vestibularis
mt = membrana tectoria
napf = nucleus of outer rod cell
n = branch of cochlear nerve
nf = medullated nerve fibers
nf$_1$ = non-medullated nerve fibers in the tunnel of Corti
orgsp = organon spirale (organ of Corti)
ph = outer phalanges
psp = prominentia spiralis
rcna = cochlear branch of the acoustic nerve
scv = scala vestibuli
sct = scala tympani
sp = sulcus spiralis
strv = stria vascularis
tb = tympanic investing lamella
vsp = vas spirale
* = phalangeal processes of outer rod cells
+ = tunnel of Corti


mv
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lspm
scv
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sct
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k
rcna

Fig. 1

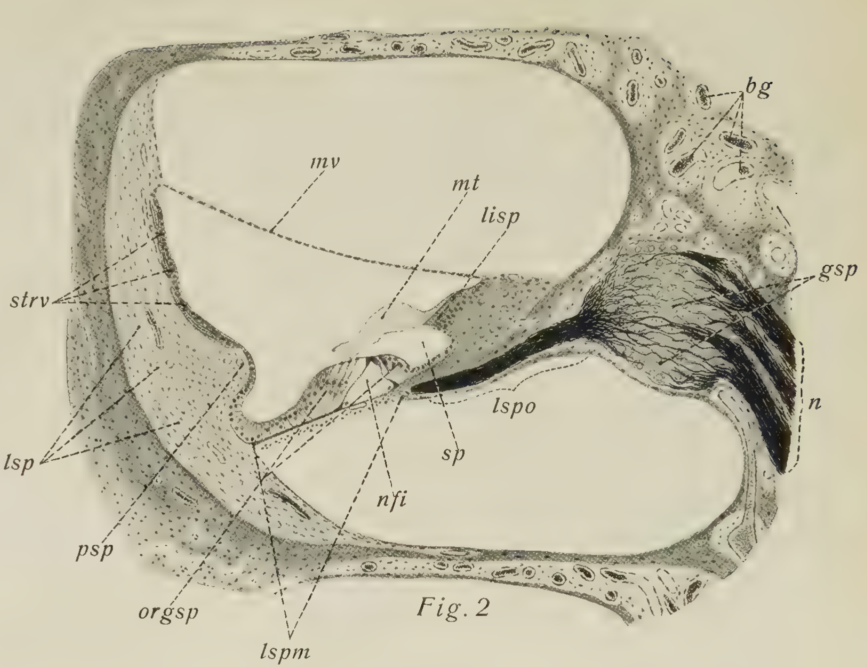
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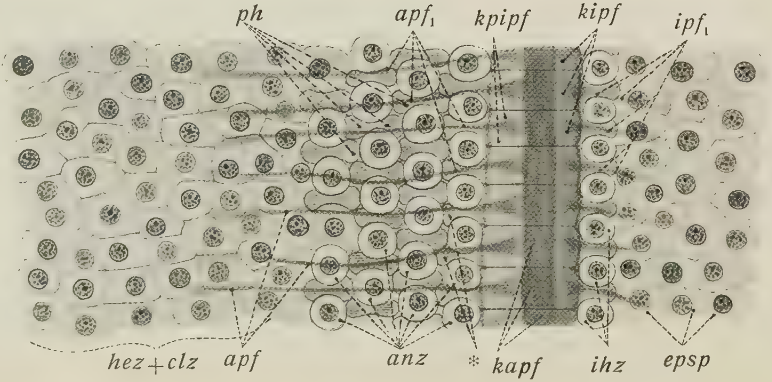
Fig. 2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anz
*
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Fig. 4

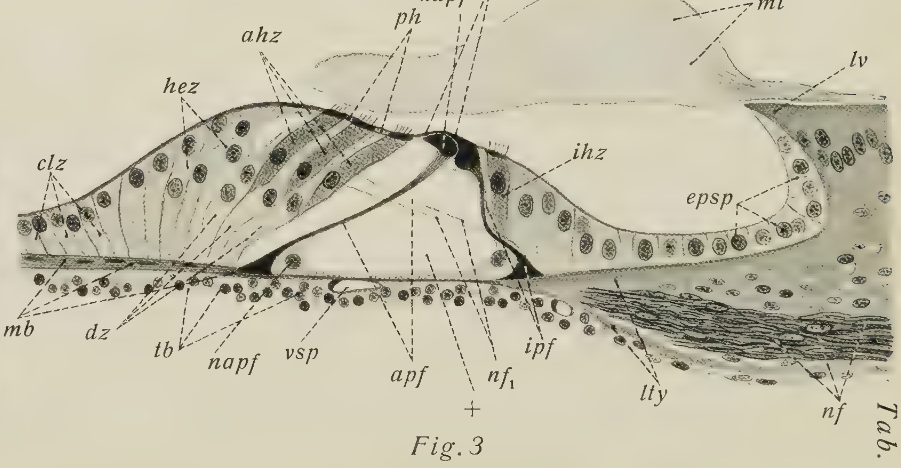
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Fig. 3

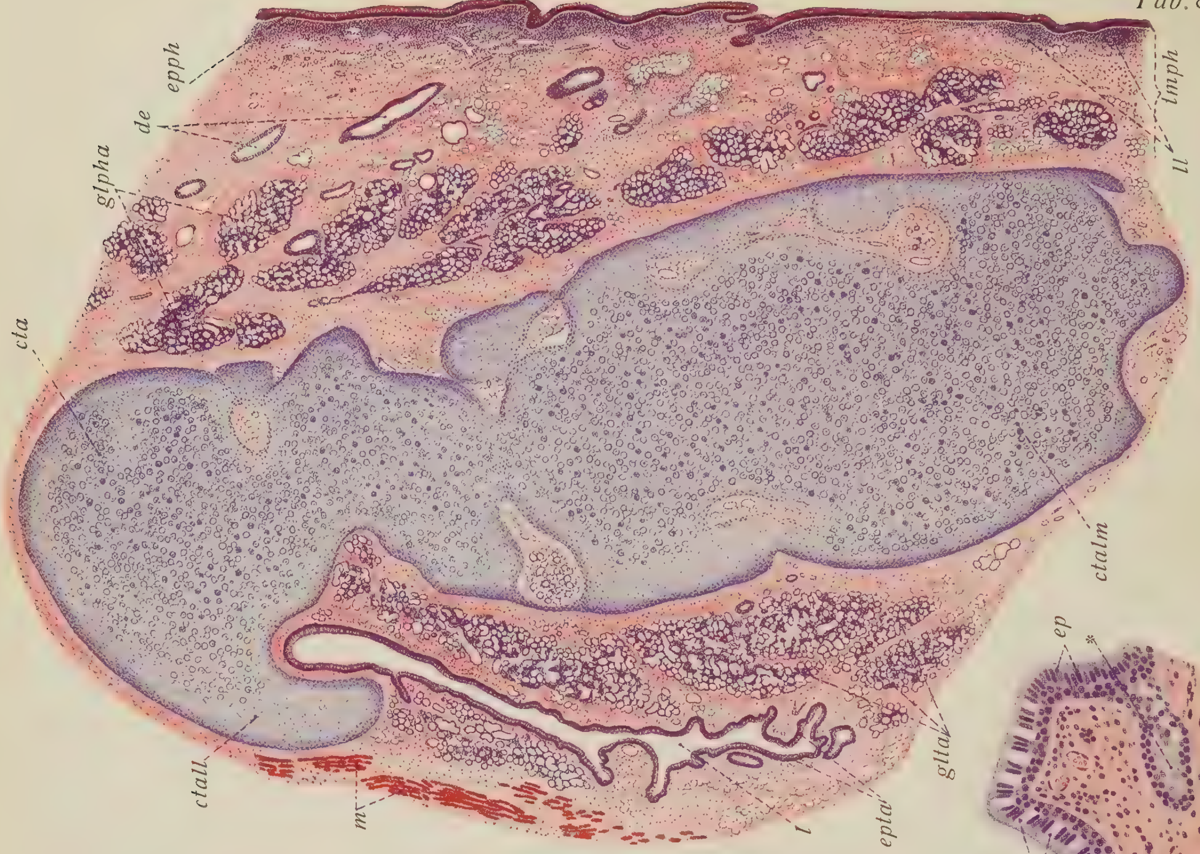
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Fig. 3

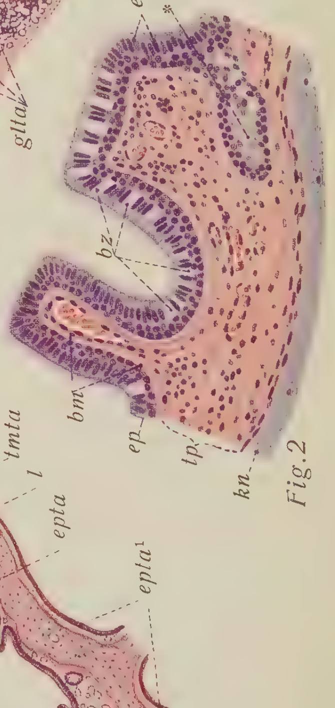
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Fig. 2

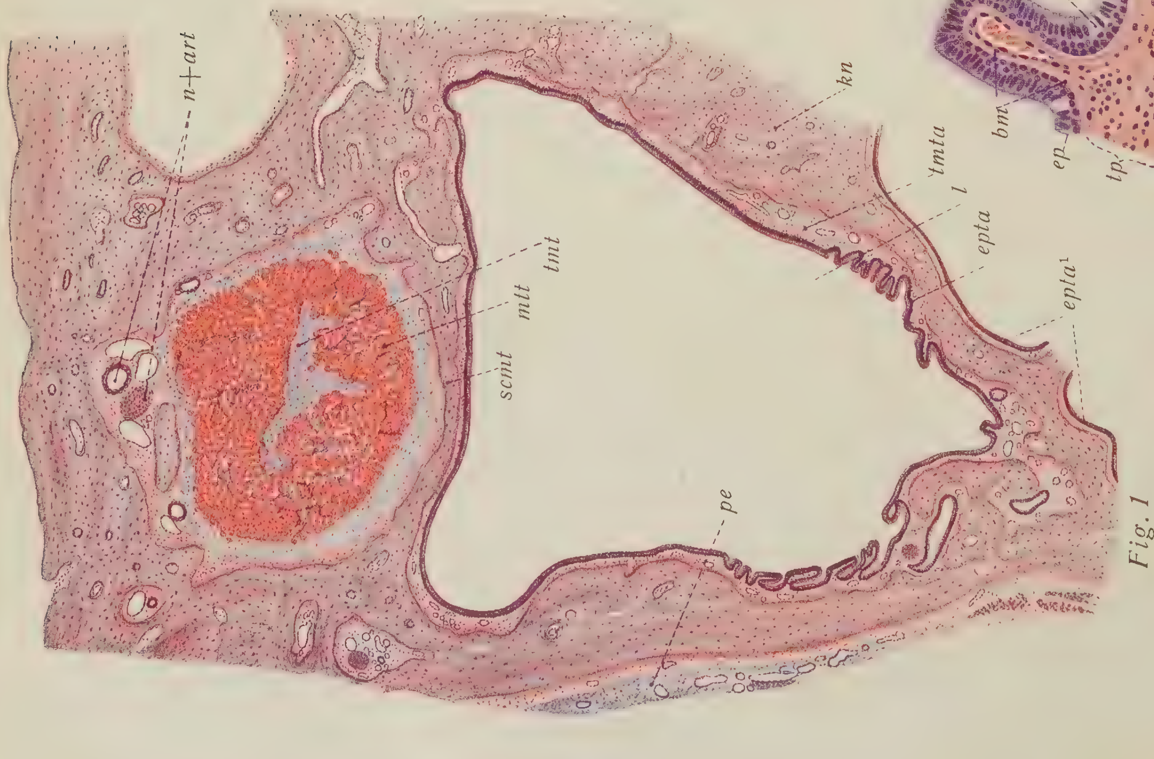
n+art
kn
tmta
l
epta
epta¹
tmt
mtt
scmt
pe

Fig. 1

Plate 86. **Middle Ear, Tuba Auditiva.**

Fig. 1. Transverse Section of the **Pars Ossea Tubae Auditivae** and the Musculus Tensor Tympani with the Adjacent Bone (Human, aet. 28. Execution). × **25.** The canalis musculotubarius is shown with its septum. The vessels and nerves of the tensor tympa niare lodged in a subdivision of the semicanal which contains the muscle, its tendon, and its external connective-tissue sheath. The tubal semicanal is lined by the mucous membrane of the bony portion of the Eustachian tube. The membrane is closely applied to the bone. The septum is complete in the region of the section. At the bend of the tube (below) are seen a number of simple evaginations of the mucous membrane and near them are two cellulae tubariae lined with epithelium. **Technique:** Müller's fluid—formol. Decalcification by picric acid. Celloidin. Haemalum-eosin.

Fig. 2. A Part of the **Osseous Portion of the Eustachian Tube.** × **200.** From the section pictured in *Fig. 1.* The ciliated epithelium shows cells in two rows, many of them being goblet cells. A distinct basal membrane separates epithelium and tunica propria. The latter is thin and rests directly upon the bone (or periosteum) and contains no glands; however evaginations, like that cut at * are present. **Technique** as for *Fig. 1.*

Fig. 3. Transverse Section through the **Pars Cartilaginea Tubae Auditivae** and the Adjacent Pharyngeal Mucous Membrane. × **13**. The figure shows a characteristic cross-section of the tube near its pharyngeal end. There are seen the long, thick, median lamina of the cartilage of the tube and the short, slender, lateral lamina; also the narrow, slitlike lumen of the cartilaginous portion of the tube, the numerous glands of the mucous membrane, and fibers of the musculus tensor palati arising from the lateral wall of the tube. On the median surface of the median lamina of cartilage, and rather closely applied to it, lies the pharyngeal mucous membrane with its glands and a marked accumulation of lymphocytes beneath its stratified ciliated epithelium. The thicker part of the tubal cartilage is penetrated in places by connective tissue containing fat. **Technique:** Picro-sublimate. Celloidin Haematoxylin-eosin.

bm = basal membrane
bz = goblet cells
cta = cartilage of the Eustachian tube
ctall = lateral lamina of cartilage of tube
ctalm = median lamina of cartilage of tube
de = excretory ducts of pharyngeal glands
ep = epithelium
epph = epithelium of pharyngeal mucous membrane
epta = epithelium of Eustachian tube
epta^1 = epithelium of the cellulae tubariae
glpha = mucous glands of the pharynx
glta = mucous glands of the tuba auditiva
kn = bone
l = lumen
ll = accumulations of lymphocytes
m = fibers of m. tensor palati
mtt = musculus tensor tympani
n + art = nerve and artery
pe = periosteum
scmt = septum canalis musculotubarii
tmph = pharyngeal mucous membrane
tmta = mucous membrane of the tuba auditiva
tmt = tendon of the m. tensor tympani
tp = tunica propria
* = evagination of mucous membrane of the tuba auditiva cut tangentially

Plate 87. **Organs of Smell and of Taste, Integument I.**

Fig. 1. From a Section Perpendicular to the Mucous Membrane of the **Regio Olfactoria** (Human, aet. 26. Execution). × **600.** The epithelium and the adjacent part of the tunica propria are shown. The section has passed across one of the islands of olfactory mucous membrane which are found scattered in the upper part of the respiratory region (cf. *Fig. 2*, Pl. 55). In the stratified epithelium there are to be seen isolated cells which clearly bear cilia attached to basal corpuscles; while the greater part of the surface of the epithelium is devoid of cilia. Other elongated conical cells which by their broader ends share in forming the surface of the epithelium are noticeable because of the dark staining of their protoplasm. The superficial end of each bears a conical process which like the neighboring cilia projects into a film of secretion. In the opposite direction there is seen an unusually slender extension of the cell reaching to the basal membrane. These are the olfactory cells. In addition to the basal and other cells two polymorphonuclear wandering cells are seen in the epithelium. The connections of the fibers of the olfactory nerve with the olfactory cells are not visible. Tangential and cross sections of alveoli of the olfactory glands are to be seen in the tunica propria. **Technique:** Zenker's fluid. Paraffine. Iron Haematoxylin.

Fig. 2. From a Vertical Section through the **Olfactory Mucous Membrane** (Human, Execution). × **250**. The upper part of the epithelium is quite dark, no structures can be recognized in it because of a precipitate of silver. A few olfactory cells are blackened and thus show their connection with the fibers of the olfactory nerve. The cells have assumed a peculiarly rounded form. **Technique:** Bichromate-osmic acid. Golgi's silver nitrate method.

Fig. 3. A Vertical Section through a **Taste Bud** (Papilla Foliata of Rabbit). × **500.** The taste bud stands out clearly from the surrounding stratified squamous epithelium, its cells being less deeply stained. The taste pore extends inward from the surface of the epithelium to the taste bud. Within the bud the taste cells bearing the taste hairs are clearly distinguished from the somewhat paler supporting cells. **Technique:** Osmic acid vapor. Paraffine. Alum carmine.

Fig. 4. **Taste Bud** (Papilla Foliata of Rabbit). × **500**. The region of the taste pore viewed from above. The crown of taste hairs stands out with especial distinctness. **Technique:** Zenker's fluid. Paraffine. Haematoxylin-eosin.

Fig. 5. Human **Epidermis** Separated from the Underlying Corium. × **60.** The epidermis is seen from beneath. The papillary pits are irregular in size and arrangement. The nuclei of the cells of the basal layer appear in the figure as points. The long thread-like structures are the ducts of sweat glands. **Technique:** Borax-carmine.

Fig. 6. From a Section of Human **Skin Cut Parallel to the Surface.** × **270.** The connective-tissue papillae are pale in the figure and stand out clearly from the darker epidermis. The papillae are immediately surrounded by the columnar cells of the basal layer of the epidermis, while the rest of the epithelial mass which fills in between the papillae is derived from the stratum dentatum. The purely cellular tissue of the epidermis is in sharp contrast to the connective tissue of the papillae with its few cells. Toward the left is seen the excretory duct of a sweat gland. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

cap = capillaries of papillae of corium
ci = cilia
dusu = excretory duct of sweat gland
dz = supporting cells
ep = epithelium
glo = glandula olfactoria
gz = taste cells
lc = wandering cells in epithelium
olf = fibers of olfactory nerve
pap = papillae
pg = taste pore
rk = olfactory cones
rz = olfactory cells
sem = membrane of secretion
stg = taste hairs
tp = tunica propria
* = superficial covering of epithelium

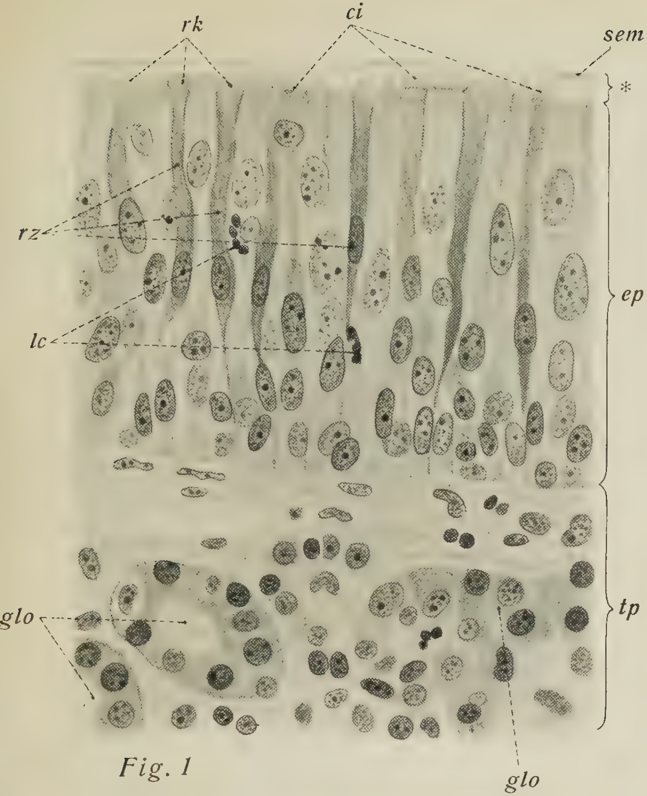
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Fig. 1

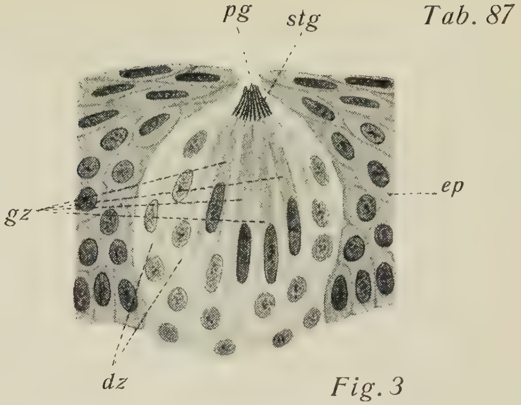
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Fig. 3

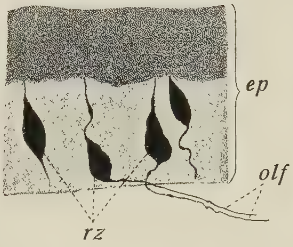

Fig. 2

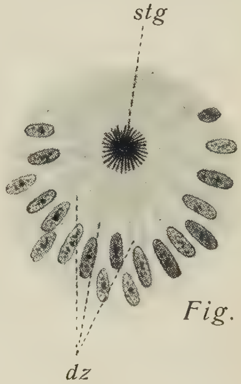

Fig. 4

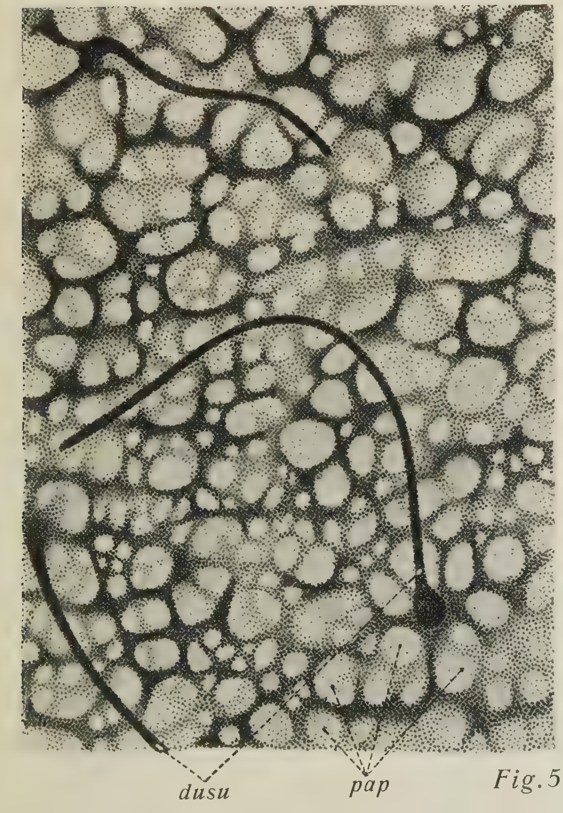

Fig. 5

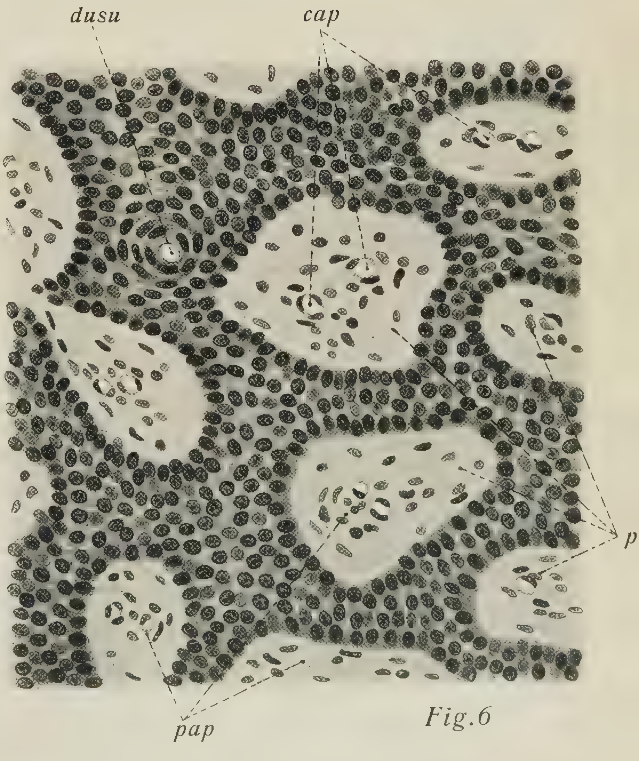
dusu
cap
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Fig. 6

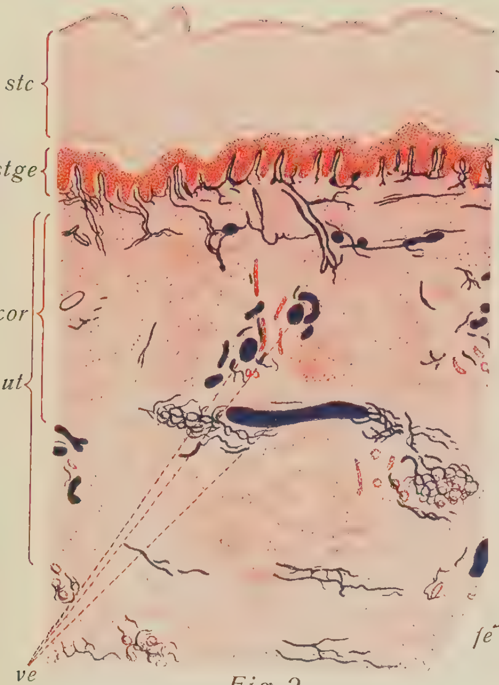
stc
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Fig. 2

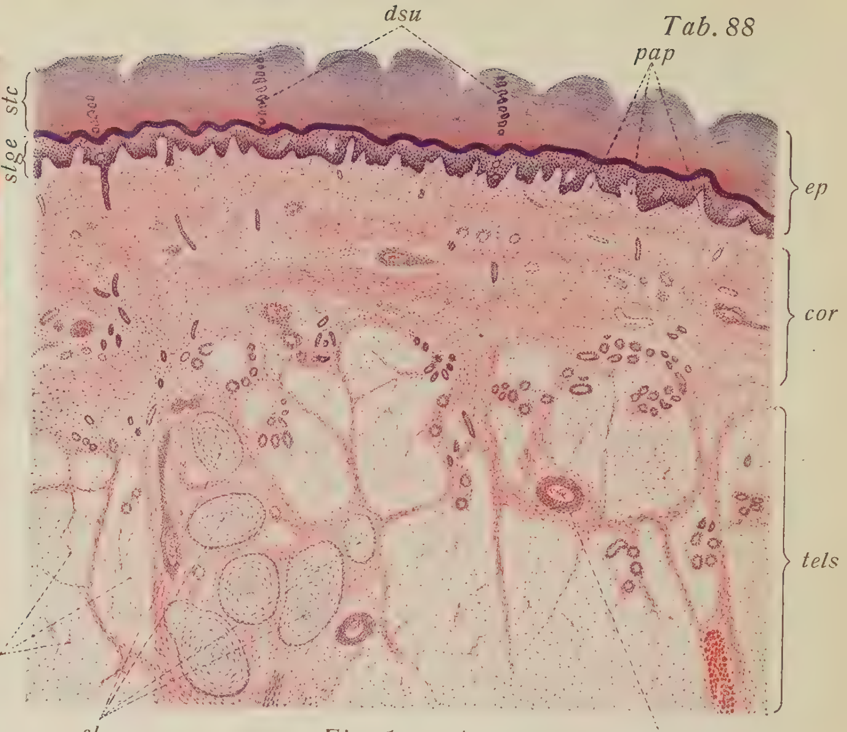
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Fig. 1

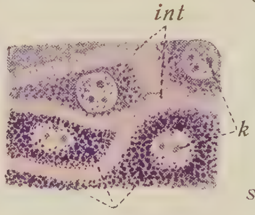

Fig. 4

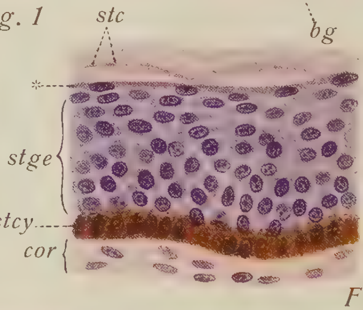
stc
*
stge
stcy
cor

Fig. 5

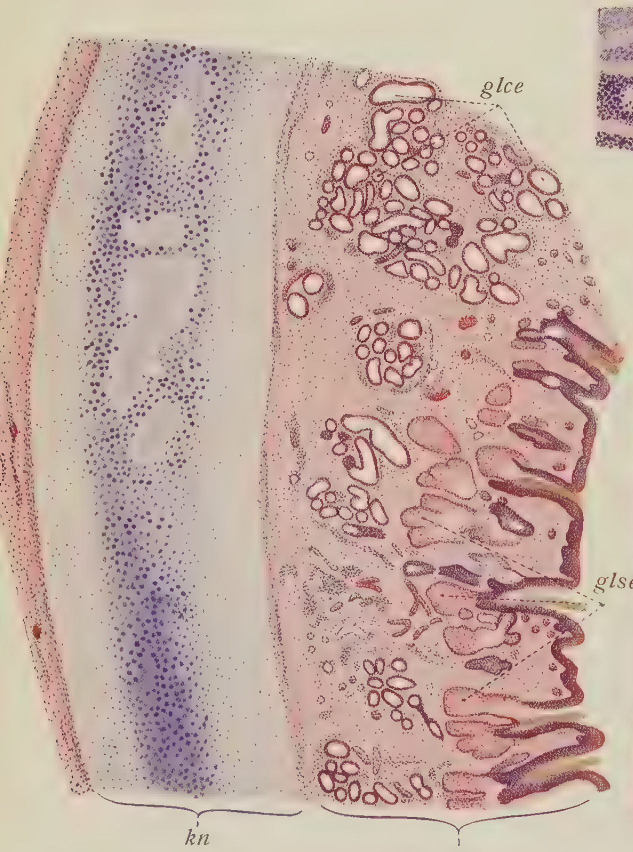
glce
glse
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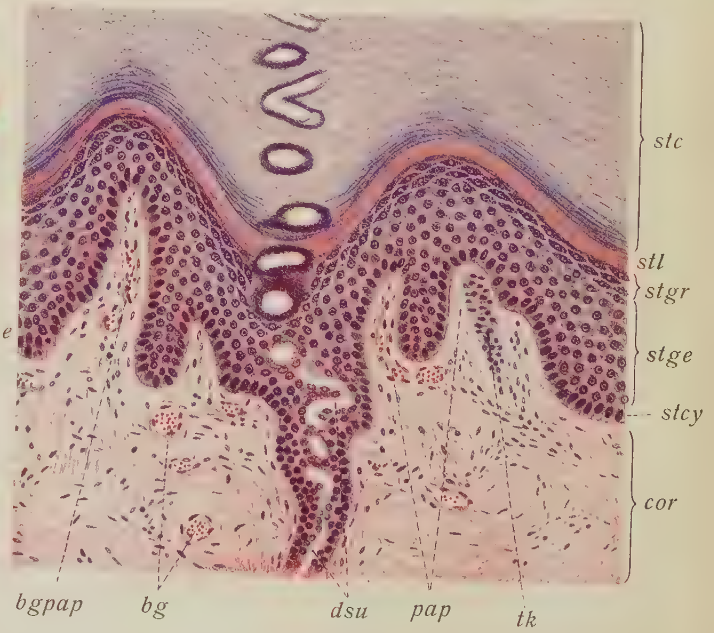
Fig. 6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stcy
cor
bgpap
bg
dsu
pap
tk

Fig. 3

Plate 88. **Integument II.**

Fig. 1. From a Vertical Section through the **Skin of the Palm of the Hand** (Human, aet. 20. Execution). × **18.**

An example of skin from a region where the papillae of the corium are long and the stratum corneum is greatly developed. Above is the epidermis with its two chief layers, the stratum corneum and the stratum germinativum; the wavy line between the two represents the stratum granulosum plus the stratum lucidum. Below is the corium with its papillae, and still deeper are the coils of the sweat glands in the upper part of the tela subcutanea. The latter consists largely of adipose tissue but contains a nest of Pacinian corpuscles and at the right, in red, a bundle of fibers of the musculus palmaris brevis. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. From a Vertical Section of **Injected Skin from the Palm of the Hand.** × **20.**

General view of the distribution of the blood vessels, which appear blue; the nuclei are red. Above is the epidermis which is devoid of blood vessels and appears red where nuclei are abundant, *i. e.* as far as the stratum granulosum. At its base it is indented by the papillae which contain blood vessels. Below are seen the corium and the tela subcutanea with their blood vessels, the veins have largely escaped injection. **Technique:** Injection with Berlin blue—gelatine. Müller's fluid. Staining in toto with borax-carmine. Celloidin.

Fig. 3. Part of a Vertical Section of **Skin from the Palm of the Hand.** × **170.**

The section shows a part of the corium and all of the epidermis except the most superficial part of the stratum corneum and displays the detail of *Fig. 1.* The area represented shows the passage of the duct of a sweat gland into the epidermis. Its wall at first is formed of cells of the stratum granulosum, then follows the corkscrew-like portion which penetrates the thick stratum corneum. Note how the epidermis is formed of stratum corneum, stratum lucidum (neither of which layers contains nuclei), stratum granulosum and stratum germinativum; the basal cells of the latter constitute the substratum cylindricum. The part of the corium displayed is chiefly the papillary layer with its long papillae in which are seen blood vessels (capillaries) and at the right a tactile corpuscle. **Technique** and source as for *Fig. 1.*

Fig. 4. Cells from the **Stratum Granulosum** of the Human Epidermis. × **800.**

The cells are quite markedly flattened and like those of the substratum dentatum (cf. *Fig. 12,* Pl. 3) are connected by intercellular bridges. Indeed no sharp dividing line can be drawn between the two layers although the cells of the stratum granulosum are distinguished by granules of keratohyalin throughout their protoplasm. **Technique** and source as for *Fig. 1.*

Fig 5. Part of a Vertical Section through the **Skin of a Human Penis.** × **350.**

An example of skin from a region with poorly developed stratum corneum and an almost complete lack of corial papillae; the section is also an example of pigmented skin. The thin stratum corneum of the epidermis rests immediately upon the stratum germinativum. The stratum lucidum is lacking and the stratum granulosum nearly so, although in greatly reduced form it is still recognizable in most regions of the skin, however thin the stratum corneum may be. Pigment, as fine melanin granules, lies exclusively in the cells of the substratum cylindricum. **Technique** and source as for *Fig. 1.*

Fig. 6. Part of a Transverse Section through the Cartilaginous Portion of the **External Acoustic Meatus** (Human, aet. 28. Execution). × **16.**

An example of a region with highly modified skin. At the left is the cartilage to the right of which is the cutaneous lining of the acoustic passage. The epidermis here lacks the stratum corneum almost entirely, while the skin is very ric hin glands. In addition to the sebaceous glands of the small hairs there are present large apocrine glands which form the cerumen. The coils of these glands occupy the entire thickness of the corium. There is no subcutaneous layer. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

bg = blood vessels
bgpap = capillaries in papillae
cor = corium
cut = cutis
cl = Pacinian corpuscles
dsu = ducts of sweat glands
ep = epidermis
fe = adipose tissue
glce = ceruminous glands
glse = sebaceous glands
gr = granules
int = intercellular bridges
k = nuclei

kn = cartilage
pap = papillae
stc = stratum corneum
stcy = substratum cylindricum
stge = stratum germinativum
stgr = stratum granulosum
stl = stratum lucidum
tels = tela subcutanea
tk = tactile corpuscle
ve = veins
* = layer of cells which in most areas of the skin contain granules of keratohyalin

Plate 89. **Integument III (Hair I).**

Fig. 1. Part of an Oblique Section of the **Scalp. Transverse Sections of the Hairs** (**Human,** aet. 28. Execution). × **30.** The section passes through the corium and cuts the roots of the hairs at the level of the sebaceous glands, the musculi arrectores, and the coils of the sweat glands. General View. Note the grouping of the hairs. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. A Vertical Section through the **Human Scalp. Longitudinal Sections of Hairs.** × **17.** General view of the roots of the hairs, their glandular and muscular appendages. The preparation extends from the epidermis to the galea aponeurotica. The roots of the hairs, may be followed through the corium and subcutaneous layer downward to the bulbs and papillae of the hairs. Note the situation of the sebaceous glands within the obtuse angles of the hairs and the oblique implantation of the latter; the origin and insertion of the musculi arrectores, several of which are cut in their entire length, and their relation to the sebaceous glands. The majority of the hairs shown in the figure are living, growing hairs but in a few places club hairs are to be seen; two of which are shown in different stages of being pushed upward in the root sheath. The preparation gives a general view of the coarser hairs of the body. **Technique** and source as for *Fig. 1.*

Fig. 3. **Transverse Section** across the Middle of the **Root of a Hair** (Human, Hair of the Head). × **220.** General view of the formation of the root of a hair from the shaft of the hair, the root sheaths, and the follicular sheaths. The part of the vitreous membrane which is of connective-tissue origin appears quite homogeneous under the method of staining here employed. In this region of the hair the cuticulae are devoid of nuclei and under this magnification appear only as a thin clear border between the shaft of the hair and the inner root sheath. Note the two principal layers which form the inner root sheath, it is here decidedly thinner than the stout outer root sheath. In the center of the shaft of the hair are the nucleated medullary cells. **Technique** and source as for *Fig. 1.*

aw = outer root sheath
bg = blood vessels (capillaries) of the hair follicle
cor = corium
duse = ducts of sebaceous glands
egl = epithelial vitreous membrane
ep = epidermis
fp = hair follicle
fpl = longitudinal fibers of hair follicle
fpr = circular fibers of hair follicle
galap = galea aponeurotica
gl = vitreous membrane
glse = sebaceous glands
glsu = sudoriferous glands
iw = inner root sheath
iw_1 = Huxley's layer
iw_2 = Henle's layer
mar = musculi arrectores pilorum
pap = papillae of hairs
pap_1 = papilla separated from a hair in the process of being shed
rp = root of hair
scp = shaft of hair
telsu = tela subcutanea
+ = young anlage of hair
* = club hair recently detached from the papilla
** = club hair widely removed from papilla

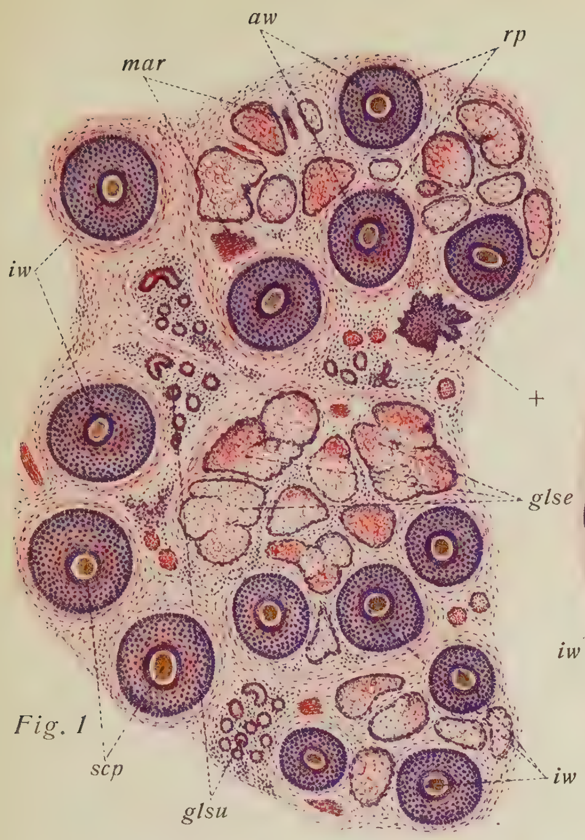
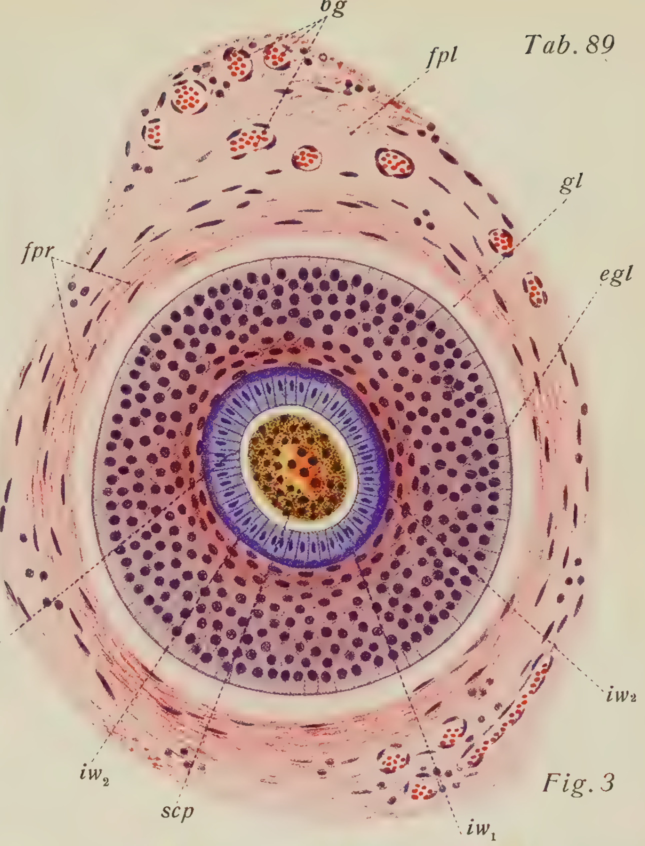

aw
mar
rp
iw
+
glse
scp
glsu
iw

Fig. 1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fpl
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egl
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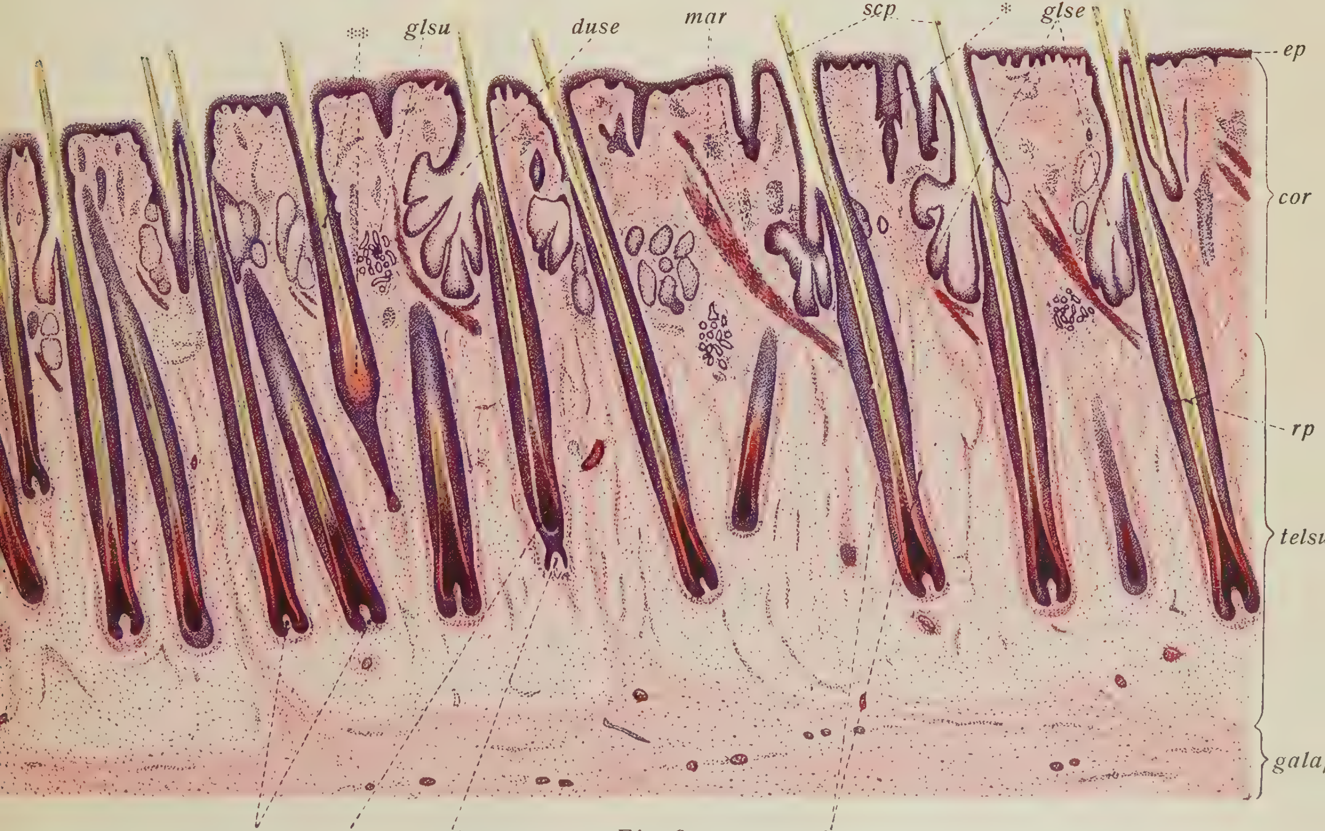
iw
iw_2
iw_2
scp
iw_1

Fig. 3


**
glsu
duse
mar
scp
*
glse
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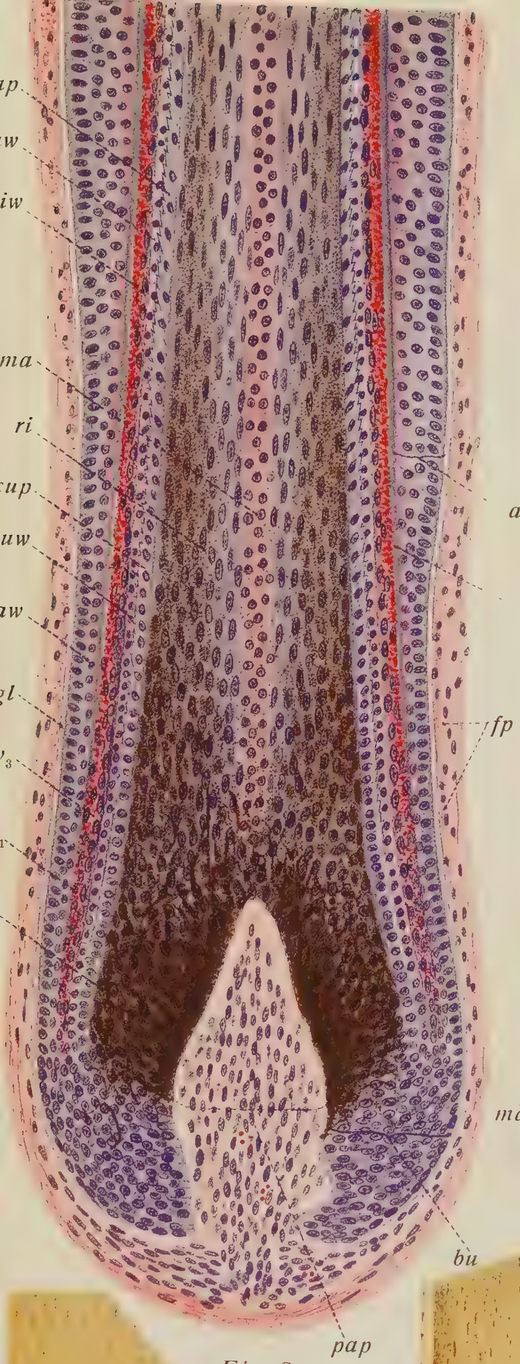
cor
rp
telsu
gala
pap
*
pap_1
fp

Fig. 2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iw_1
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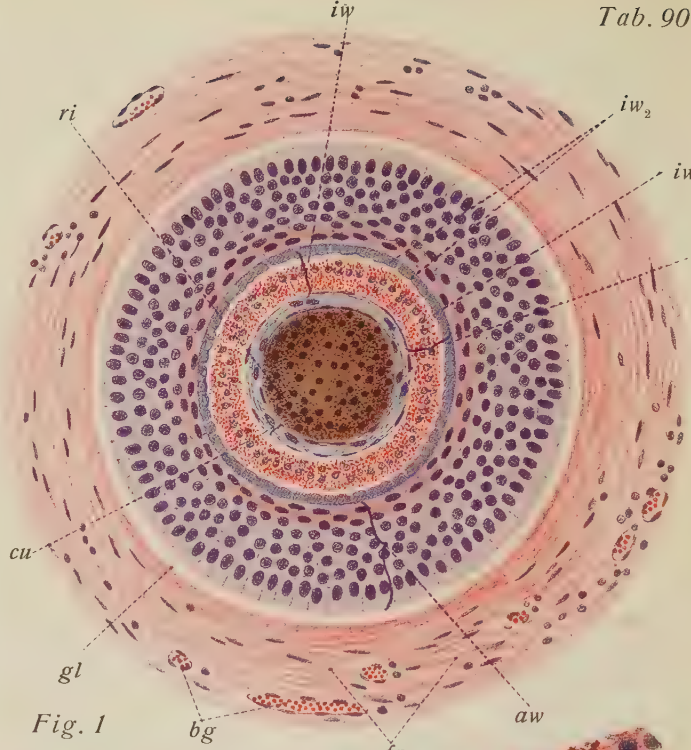
Fig. 2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iw_1
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bg
fp
aw

Fig. 1

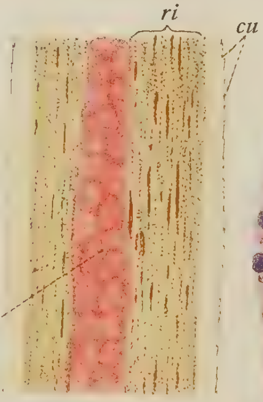

Fig. 4

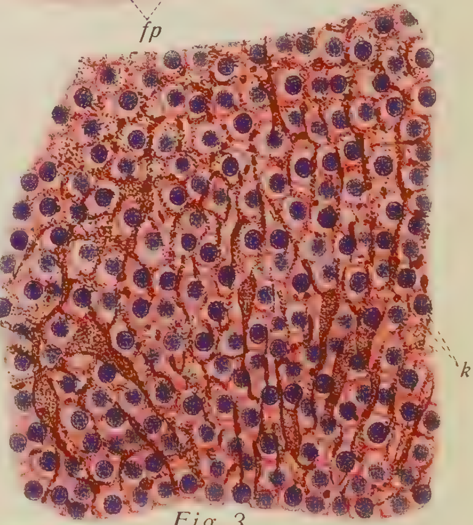

Fig. 3

Fig. 8

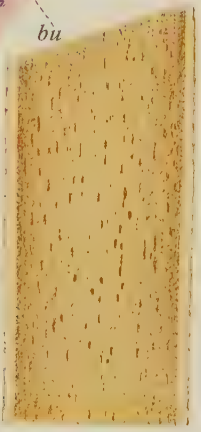

Fig. 7

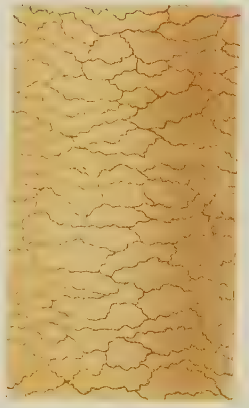

Fig. 6

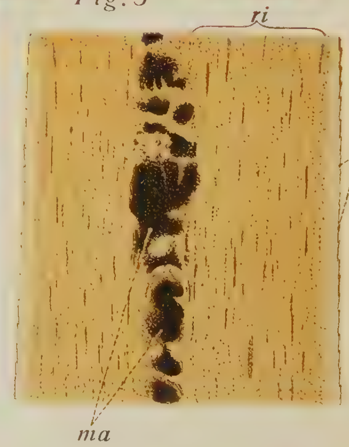

Fig. 5

Plate 90. **Integument IV (Hair II).**

Fig. 1. **Transverse Section** through the Lower Part of the **Root of a Hair** from the Scalp (Human, aet. 28. Execution). × **300.** The hair follicle is seen with its longitudinal and circular fibers, the vitreous membrane, the outer root sheath (thin at this level), the inner root sheath with its two layers (in Huxley's layer are numerous trichohyalin granules stained red). Then follow the cuticulae and the dark pigmented shaft of the hair which here consists only of cortical cells. The level of the section corresponds almost exactly to the upper border of *Fig.* 2. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Lower Portion of a **Longitudinal Section of the Root of a Hair** (Human, aet. 28. Execution). × **200**. The hair is represented along with the root sheaths and the connective tissue hair follicle. The bulb of the hair and the papilla are below; the section extends upward to the region where the thickening of the outer root sheath begins (cf. the general view of *Fig.* 2, Pl. 89). Note how the differentiation of the layers of the hair and of the root sheath proceeds from the indifferent matrix of the lower part of the bulbus pili. The same is true of the pigmentation. **Technique** as for *Fig. 1.*

Fig. 3. **Pigment Figures in the Bulbus Pili.** × **500.** From a longitudinal section of a human hair. Peculiar branched pigment figures are seen between the cells of the matrix of the hair. The section is from the upper region of the bulb where the formation of pigment is proceeding. **Technique** as for *Fig. 1.*

Figs. 4 and 5. **Parts of a Longitudinal Section of a Human Eyelash.** × **380.** From a section through an eyelid. *Fig. 4* shows the part of the hair lying within the skin; *Fig. 5* shows the free part of the shaft which has grown out beyond the eyelid. Both figures are at the same magnification! The hair contains a broad medulla which in the free portion lodges considerable air (black). Granular pigment is plentiful in the cortex and cuticular projections show distinctly upon the surface. Note that the hair is decidedly thicker in its free part than it is in the region of its root. **Technique** as for *Fig. 1.*

Fig. 6. A Very Thick **Human Hair. Blond.** × **250.** Surface view of a hair from the head. The cells of the cuticle of the hair are clearly seen with their slightly wavy boundaries. The hair is considerably thicker than that of *Fig.* 4.

Fig. 7. A Thin **Human Hair, Brown** and without Medulla. × **450.** Optical section through the axis of a hair from the head. In addition to the pale diffuse pigment there are seen many pigment granules. The individual cortical cells which compose the hair are not visible nor is a medulla present. On the outside the cuticle is in evidence as small saw-tooth-like notches.

Fig. 8. A **Hair of Medium Size. Blond (Human).** × **200.** Optical section through the axis of a hair from the head. The hair contains no medulla and only a very small quantity of granular pigment.

aw = outer root sheath
bg = blood vessels
bu = bulb of hair
cu = cuticulae
cup = cuticula of hair
cuw = cuticula of sheath
cuw_1 = cuticula of sheath in the region of bulb of hair
fp = hair follicle
iw = inner root sheath

iw_1 = Huxley's layer
iw_2 = Henle's layer
iw_3 = inner root sheath in region of bulb of hair
gl = vitreous membrane
kk = nuclei of cells of matrix
ma = medulla of hair
pap = papilla pili
pi = pigment
ri = cortex of hair

Plate 91. **Integument V (Nails, Sweat Glands I).**

Fig. 1. **Longitudinal Section** of the Posterior Part **of a Nail** (Newborn Child). × **30.** General view of the structure of the posterior part of a nail. The margo occultus is seen lodged in the nail groove, the adjacent part of the nail is free and rests upon the nail bed. The nail is composed of stratum corneum and stratum germinativum. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. **Transverse Section of a Nail** (Child, aet. 2). × **25.** The figure shows about two-thirds of the whole section. On the right the lateral margin of the nail is seen in the nail groove, while the overlying nail wall has been raised from the surface of the nail. The longitudinal ridges of the nail bed stand out clearly although the magnification is but slight. **Technique** as for *Fig. 1*

Fig. 3. Part of a **Transverse Section of a Nail** of a Child. × **70.** There is a very noticeable interlocking between the longitudinal ridges of the nail and those of the nail bed. The two layers, stratum corneum and stratum germinativum, which compose the nail are clearly marked. Note that both stratum lucidum and stratum granulosum are entirely lacking. **Technique** as for *Fig. 1.*

Fig. 4. A **Sweat Gland from the Human Scalp.**[1] × **60.** As a result of the section being relatively thick the entire length of the gland and the whole of its small coil are visible. It belongs to the short type of sweat gland with small coil and lies throughout its whole extent within the corium. Note the flattened form of the coil which is viewed in profile. **Technique** as for *Fig. 1.*

Fig. 5. A Section through the **Coil of a Human Axillary Sweat Gland.**[1] × **60.** The axillary sweat glands have short excretory ducts but greatly developed coils. There is seen the wide lumen of the tube which is cut in different directions and in places tangentially. When cut thus the myo-epithelial cells appear especially distinct as fine lines, in some of which are elongated nuclei. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Fig. 6. Transverse Section through the **Duct** of a Human[1] **Axillary Sweat Gland.** × **180.** The formation of the wall of the duct from membrana propria, myo-epithelial cells and a high, palisade-like columnar epithelium is quite distinct. In the lumen are masses of secretion (cf. P. 92). **Technique** as for *Fig. 5.*

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[1] All preparations from adults are derived from individuals who had been executed.

bg = blood vessels
cl = ridges of corium
cor = corium
de = excretory duct
ep = eponychium
epd = epidermis
epz = epithelial cells
glm = fibers of smooth muscle
glsu = coil of sweat gland
$glsu_1$ = sections of coil of sweat gland
kglm = nuclei of fibers of smooth muscle

kmsch = stratum germinativum
ma = matrix of nail
mla = margo lateralis
mo = margo occultus
mpr = membrana propria
nb = bed of nail
nl = ridges of nail
npl = nail plate
nw = nail wall
pa = papillae
* = tangential sections of sweat gland

Tab. 91

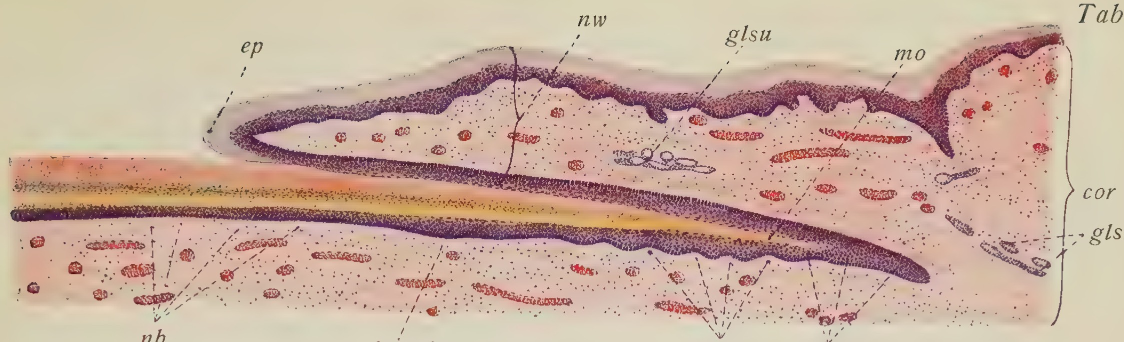
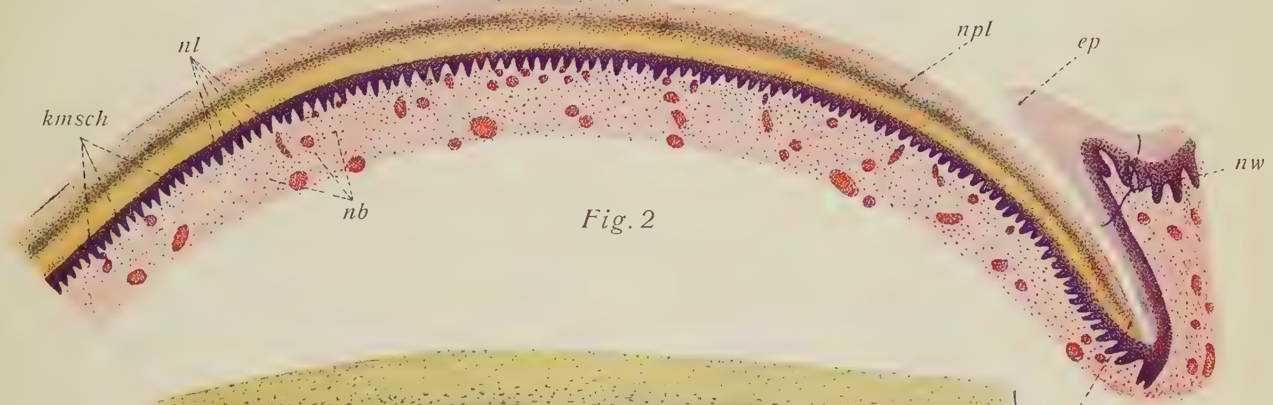

ep
nw
glsu
mo
cor
glsu
nb
kmsch
pa
ma

Fig. 1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ep
nw
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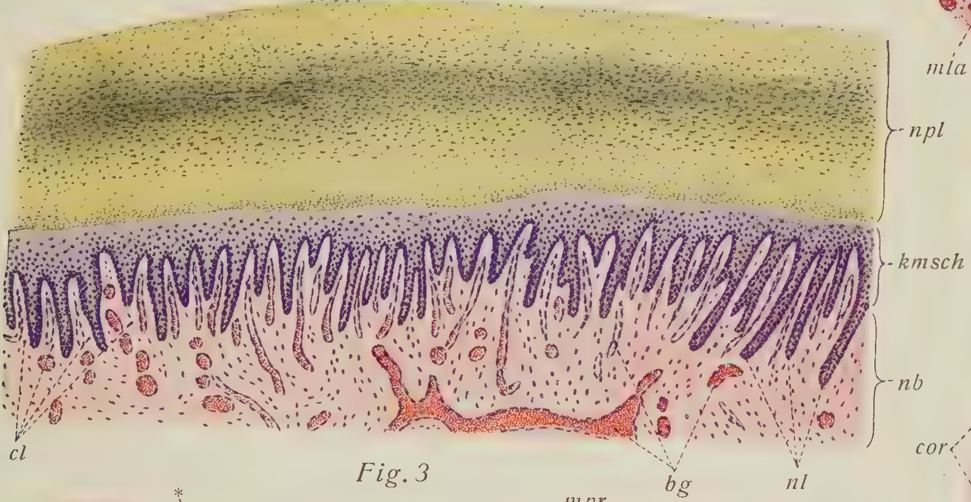
Fig. 2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kmsch
nb
cl
bg
nl

Fig. 3

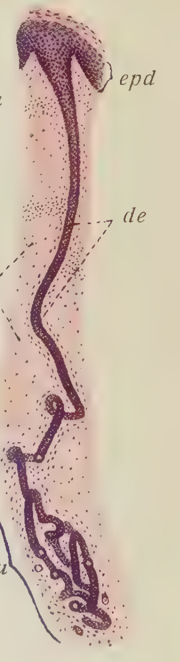
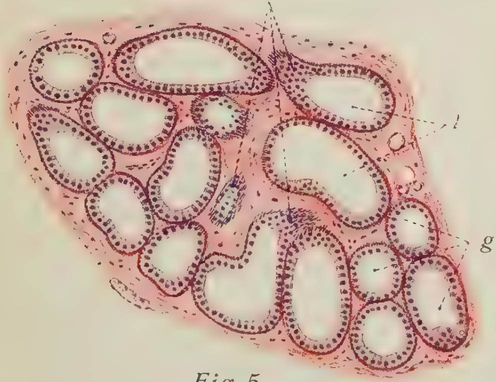

epd
de
cor
glsu

Fig. 4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l
glsu_1

Fig. 5

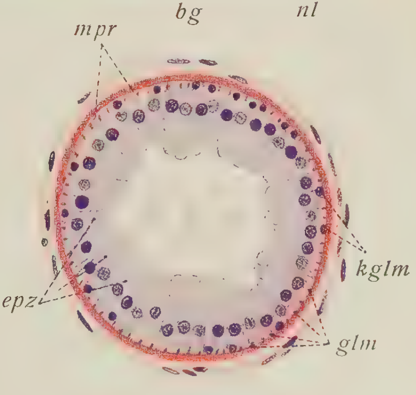
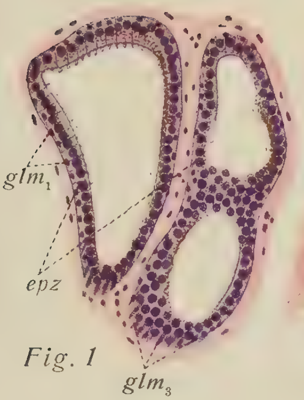

mpr
kglm
epz
glm

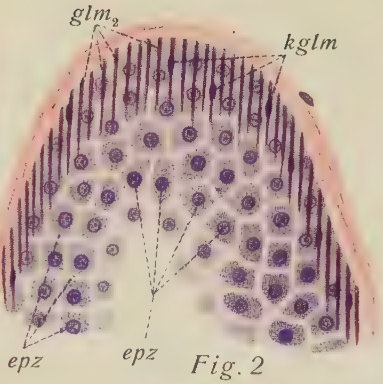
Fig. 6

Tab. 92



glm_1
epz
glm_3

Fig. 1



glm_2
kglm
epz
epz

Fig. 2

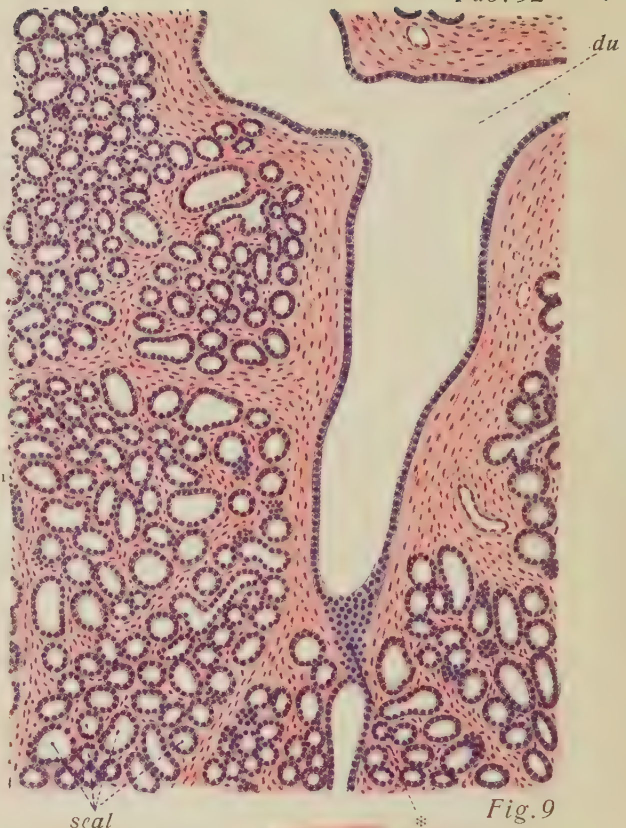
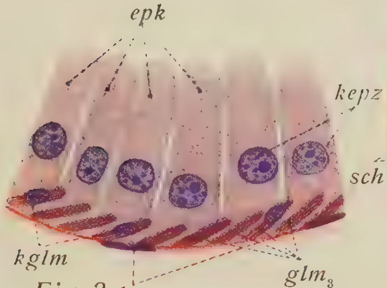
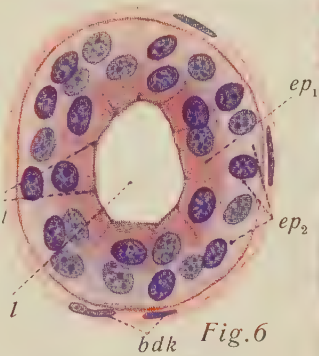


Fig. 9



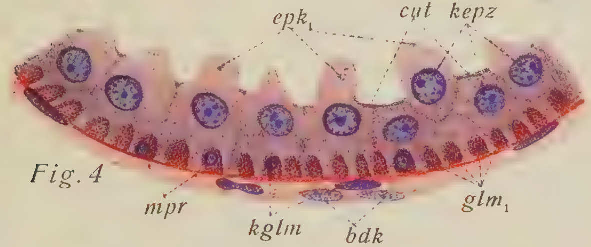
epk
kepz
kglm
kmpr
glm_3

Fig. 3



ep_1
schl
ep_2
l
bdk

Fig. 6



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kglm
bdk
glm_1

Fig. 4

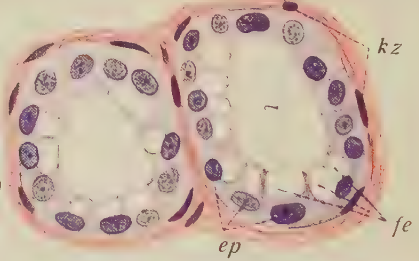
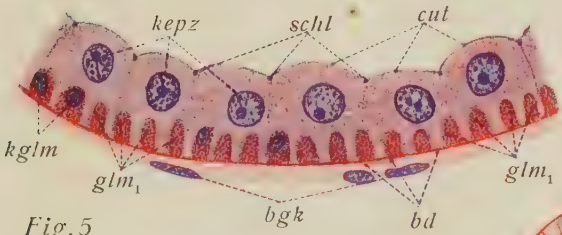


Fig. 10



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schl
cut
kglm
glm_1
glm_1
bgk
bd

Fig. 5

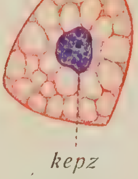

Fig. 8

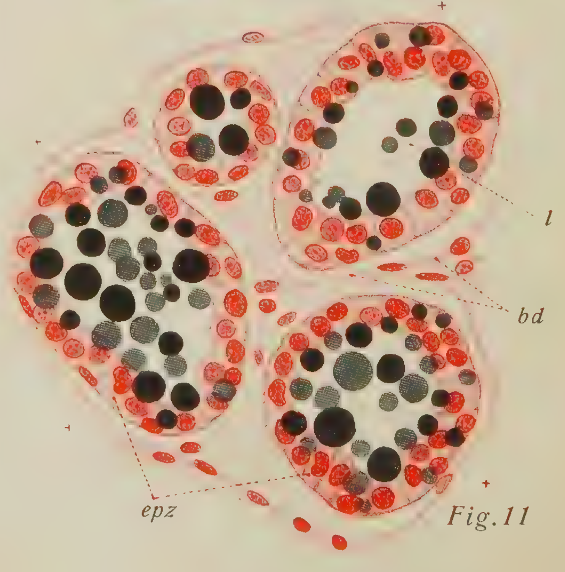

Fig. 11

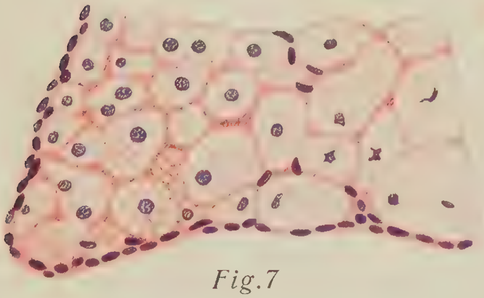

Fig. 7

Plate 92. Integument VI (Cutaneous Glands II).

Fig. 1. Part of a Section through the Coil of a **Ceruminous Gland** from the External Acoustic Meatus (Human, aet. 28. Execution). × **120.**

The gland belongs to the large apocrine sweat glands. Even under this enlargement there are seen projecting into the lumen processes from the epithelial cells engaged in secretion. In addition the cells contain the yellow pigment characteristic of the cerumen. The layer of myo-epithelial cells is seen in some places to be cut across and in others to be cut longitudinally. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 2. Part of a Very Oblique Section through the Wall of an **Axillary Sweat Gland** (Human, aet. 22. Execution). × **220.**

Toward the center the section passes through the inner, secreting cells which form a mosaic. Laterally and above are the myo-epithelial cells which for some distance are seen in almost exactly longitudinal section. Note their open arrangement and the nuclei which are cut in certain of them. The membrane propria of reticulum is seen forming the external layer. **Technique:** Zenker's fluid. Celloidin. Haematoxylin-eosin.

Figs. 3—5. Parts of Sections through the Wall of a Human **Axillary Sweat Gland.** × **640.**

In *Fig. 3* the process of forming secretion is complete, the cells so engaged are long and palisade-like with very distinct cell boundaries. The secretion has accumulated in the parts of the cells next to the lumen, while the nuclei occupy a basal position. There is no cuticular border. The myo-epithelial cells are cut somewhat obliquely. On the outside is seen the membrana propria containing nuclei. In *Fig. 4* the cells are beginning to abstrict off their tops filled with secretion; at the same time the parts of the cells which remain, and which contain the nuclei, show a cuticular border forming on their surface. The myo-epithelial cells are cut almost exactly transversely; four of them show nuclei. In *Fig. 5*, the secretion has been entirely discharged; the cells now appear cubical (cf. *Fig. 3!*) with distinct cuticular border and terminal bars. Still more clearly than in *Fig. 4* the myo-epithelial cells are seen to be cut across and set in deep, basal grooves in the secreting epithelial cells. **Technique** and source as for *Fig. 2.*

Fig. 6. Transverse Section of the **Excretory Duct of a Human Axillary Sweat Gland.** × **640.**

In addition to the membrana propria the wall of the duct is formed of two layers of epithelial cells. The inner layer, which shows a cuticular border and terminal bars, is the direct continuation of the secreting cells in the coil of the gland; the outer layer is the continuation of the myo-epithelium which has passed over into ordinary epithelial cells. **Technique** and source as for *Fig. 2.*

Fig. 7. Part of a Section through a **Sebaceous Gland** from the Ala of the Nose (Human, aet. 28. Execution). × **280.**

At the left and below is the exterior of the alveolus, in which region are to be found the smallest cells, as yet devoid of lipoid secretion. Gradually the cells increase in size and the vacuolated appearance of the cytoplasm becomes more and more distinct. Finally the cells become large elements, a part of the protoplasm of which forms an external membranelike zone, while the rest is reduced to acting as the thin walls of vacuoles. Within the enlarged cell is the greatly shrunken, pycnotic nucleus. **Technique:** Müller's fluid. Celloidin. Haematoxylin-eosin.

Fig. 8. A Single **Cell** from a Human **Sebaceous Gland.** × **280.**

The vacuoles in the cytosome are distinct and have been formed by the solution of the droplets of lipoid secretion. The pycnotic nucleus is indented. **Technique** as for *Fig. 7.*

Fig. 9. Part of a Section from a Human **Mammary Gland During Lactation.** × **75.**

In the middle one of the larger excretory ducts is seen to divide; on both sides of it are lobules of the gland separated by interlobular connective tissue. Note the relatively wide lumina of the alveoli and the rather flat epithelium which forms their walls. **Technique:** Sodium chloride—sublimate solution. Paraffine. Haematoxylin-eosin.

Fig. 10. Sections through Two Alveoli of a Human **Mammary Gland During Lactation.** From the preparation pictured in *Fig. 9.*

The fat droplets which formed in the superficial zone of the epithelium appear as vacuoles. Some cells (flat-cubical) have already discharged their secretion, others (columnar) are in the process of forming secretion. **Technique** as for *Fig. 9.*

Fig. 11. Four Alveoli from a Human **Mammary Gland During Lactation.**

The droplets of fat have been blackened by the action of osmic acid. Many of them have already been cast off into the lumen. **Technique:** Flemming's potassium bichromate—osmic acid solution. Paraffine. Saffranin.

bd = connective tissue
bdk (bgk) = nuclei of connective tissue
cut = cuticular border
du = excretory duct
ep = epithelium
ep_1 = inner layer of epithelial cells
ep_2 = outer layer of epithelial cells
epk = ends of cells filled with secretion
epk_1 = ends of cells in process of abstriction
epz = cells of glandular epithel.
fe = droplets of fat
glm_1 = fibers of smooth muscle cut transversely
glm_2 = the same cut longitudinally
glm_3 = the same cut obliquely
kepz = nuclei of epithelial cells
kglm = nuclei of fibers of smooth muscle
kmpr = nuclei of membrana propria
kz = nuclei of basket cells
l = lumen
mpr = membrana propria
schl = terminal bars
seal = secreting alveoli
* = tangential section of wall of duct

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